Phosphorus Control Plans for the Essex Junction and Essex Town MS4s

STONE ENVIRONMENTAL



Village of Essex Junction

Town of Essex — Incorporated June 7, 1763 — Essex Vermont

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Acknowledgements and Disclaimer

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The intent of this plan is to present data collected, evaluations, analysis, and cost estimates for the Essex Junction and Essex Town Phosphorus Control Plans, completed under a contract between the Village of Essex Junction and the consultant team, including Stone Environmental, Inc., Horsley Witten Group, and Stantec. The Essex Junction and Essex Town PCPs were prepared to meet compliance requirements for the *VPDES General Permit 3-9014 (2018) for Stormwater Discharges from Regulated Small Municipal Separate Storm Sewer Systems (MS4s) and Certain Developed Lands* for the Village of Essex Junction and the Town of Essex. The presented plan is in draft form and will be revised by the MS4 partners as needed. Further, it will remain a working document, subject to change as projects are further investigated. Neither of the MS4s are bound in any way to the proposed BMP lists included in this plan document. This PCP and its implementation are contingent upon the MS4s' ability to gain permits and to gain municipal funding approval.

Phosphorus Control Plans for the Essex Junction and Essex Town MS4s

Cover Photo: This swale, at the intersection of South Street and Wilkinson Drive in Essex Junction, is one promising site where an infiltrating stormwater retrofit may be constructed to help meet MS4 phosphorus reduction requirements.

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1. Introduction

As required by the Vermont Municipal Separate Storm Sewer System General Permit (MS4 Permit)[1], the Village of Essex Junction and Town of Essex are required to develop Phosphorus Control Plans (PCPs) "designed to achieve a level of phosphorus (P) reduction equivalent to the percent reduction target for developed land in the associated TMDL lake segment(s) as applied to municipally owned developed lands".

Developed lands that are not under the Village's or Town's ownership or control are not the MS4s' responsibility under this PCP. Developed lands owned and controlled by the Vermont Agency of Transportation (VTRANS), for instance, are regulated under the Vermont DEC *General Permit 3-9007 for Stormwater Discharges from the State Transportation Separate Storm Sewer System (TS4)* and its attendant PCP requirements. VTrans roadways and rights-of-way were not included in Essex Town's MS4 impervious or pervious surface areas to be managed under the PCP. Portions of VT Route 15 and VT Route 2A were similarly excluded for Essex Junction (Section 2). The MS4s may, however, coordinate with VTrans regarding implementation of individual retrofits or other projects where it is mutually beneficial for them to do so.

Similarly, school properties in Essex Junction and Essex Town are all part of the Essex Westford School District, and many of the school facilities have operational stormwater permits from Vermont DEC. These properties are owned and controlled by the school district, so although they are quasi-municipal in nature these properties are not included in the MS4s' PCP areas or phosphorus target reductions. Most of the Essex Westford school campuses located in Essex Junction and Essex Town are subject to the "3-acre site" requirements of Vermont DEC General Permit 3-9050[2], and are therefore required to obtain permit coverage and retrofit subject sites to improve the level of stormwater treatment. While schools are not part of the Village or Town MS4 areas, school properties may have open space that represents opportunity for collaboration on retrofits that benefit both the School District and the MS4(s), and this PCP retains flexibility for schools and MS4s to work together in the future.

The Phosphorus Control Plan first documents the areas and resulting phosphorus base load subject to the conditions of the PCPs. It then describes progress towards target P reductions achieved by the Essex Junction and Essex Town MS4s through implementation of structural stormwater treatment practices (STPs) owned, controlled, or maintained by the MS4s via inspection/maintenance agreements, through improvements to hydrologically connected road segments and culvert outlets, and through performance of non-structural practices such as street sweeping and catch basin cleaning within their PCP areas from 2010-2020.

The PCP then documents a menu of structural STPs, municipal road segment and culvert outlet repairs, enhanced non-structural controls (particularly street sweeping), and implementation of enhanced ordinances or regulations to address sub-jurisdictional impervious surfaces that the Essex Junction and Essex Town MS4s may use to achieve required P reductions from municipally-owned developed lands.

[1] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/VT%20MS4%20GP%202018.pdf
[2] https://dec.vermont.gov/watershed/stormwater/9050/3-acre-properties

While the plan is conservative and demonstrates both the Village and Town have identified sufficient improvements to meet and exceed their target phosphorus reductions, elements related to hydrologically connected road segments meeting standards will necessarily change based on re-inventory, road and outlet maintenance practices, and on the frequency and intensity of future storm events. Thus, the presented plan is in draft form and will be revised by the MS4 partners as needed. This PCP is contingent on Board approval or adoption for both Essex Junction and Essex Town. It will remain a working document, subject to change as projects are further investigated. Implementation of the PCP is also contingent upon the MS4s' ability to gain permits and to gain municipal funding approval.

2. Phosphorus Control Plan Areas, Base Loads, and Reductions Required

Using GIS datasets and spreadsheet summaries, Stone estimated the developed lands P base load and target load reductions for the Village and Town's rights-of-way (ROW), municipally owned parcels, and other municipally owned or controlled lands that collectively constitute the PCP area[3] (Map 1). Roadways, rights-of-way, and facilities owned and controlled by VTrans but located within the Village or Town were excluded. The Village of Essex Junction is required to meet an annual P load reduction target of 31.7 kg/yr, while the Town of Essex must reach a P reduction target of 74.6 kg/yr - a 20% reduction from base conditions for both municipalities (Table 1).

Table 1. Phosphorus base loads and reduction targets by lake segment[3]

Lake Segment	Drainage Area	Acres (All Developed Land Use Classes)	P Base Load (kg/yr)	Total Developed Lands P Target Reduction	Total P Reduction Target (kg/yr)
Village of Essex Junction Summary					
Main Lake	Winooski River	208.8	111.9	20.2%	22.6
Malletts Bay	Malletts Bay - DD	133.8	44.5	20.5%	9.1
Total		*342.5*	*156.4*		*31.7*
Town of Essex Summary					
Main Lake	Winooski River	378.7	215.8	20.2%	43.6
Malletts Bay	Lamoille River	85.2	83.9	20.5%	17.2
Malletts Bay	Malletts Bay - DD	145.2	67.3	20.5%	13.8
Total		*609.2*	*367.0*		*74.6*

Note: The P base loads and target P reductions were developed using the developed lands GIS dataset and loading rate tables provided by VT DEC in January 2019. VT DEC updated the loading rate tables in fall 2019 to include classifications for developed pervious land use by hydrologic soil group. The P base loads were re-calculated based on the updated loading rate table, but this update did not significantly change the P base loads for Essex Village/Town.

[3] Stone Environmental (2020) "Essex Phosphorus Control Plans – Revised Drafts of Area, Base Load, and Target Reductions" Submitted to Essex Town & Village and ANR January 15, 2020.

3. Structural Stormwater Treatment Practices

Structural STPs that may be credited towards P reduction for the PCP per Section 8.2.A.3 of the MS4 Permit[1] include:

- Retrofits to municipally owned properties;
- Implementation of STP upgrades or retrofits to treat existing impervious after the adoption of the 2002 VSMM;
- Implementation of STPs after July 1, 2010 on developed lands not subject to the state's operational stormwater permit;
- Management of stormwater and STPs including non-municipally-owned lands subject to an operational stormwater permit that does not otherwise require an upgrade of the stormwater system to comply with Vermont Department of Environmental Conservation (DEC) stormwater regulations, provided that the MS4 assumes responsibility for the stormwater system and/or establishes a maintenance agreement with the property owner(s) to ensure maintenance.

Phosphorus reductions were calculated for constructed and design-phase STPs under Essex Village/Town ownership or management jurisdiction, and which are eligible for P reduction credit, using the Agency of Natural Resources' (ANR) Best Management Practice (BMP) Tracking Table[4].

The annual P load reductions achieved or expected from completed and design-phase structural STPs summarized in Figure 1 range from over 150% of the PCP Area's target load allocation (12.7 kg/yr) in Essex Junction's Malletts Bay Lake segment, to roughly a third of the target P load reductions in the Village's Main Lake segments. In the Main Lake segment for both the Town and Village, identification of additional projected structural STPs was completed to meet target P reductions. If and as the Town prefers to implement structural STPs outside of its Sunderland Brook stormwater-impaired watershed area in order to meet its MS4 phosphorus reduction obligations, the structural STPs projected in the Alder Brook watershed and in Winooski River direct drainages may be advanced in coordination with MRGP outlet rehabilitation, stormline replacements, or other strategic retrofit efforts. Details of the structural STPs are presented below.

[4] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/BMPTrackingTable_03132020.xlsx

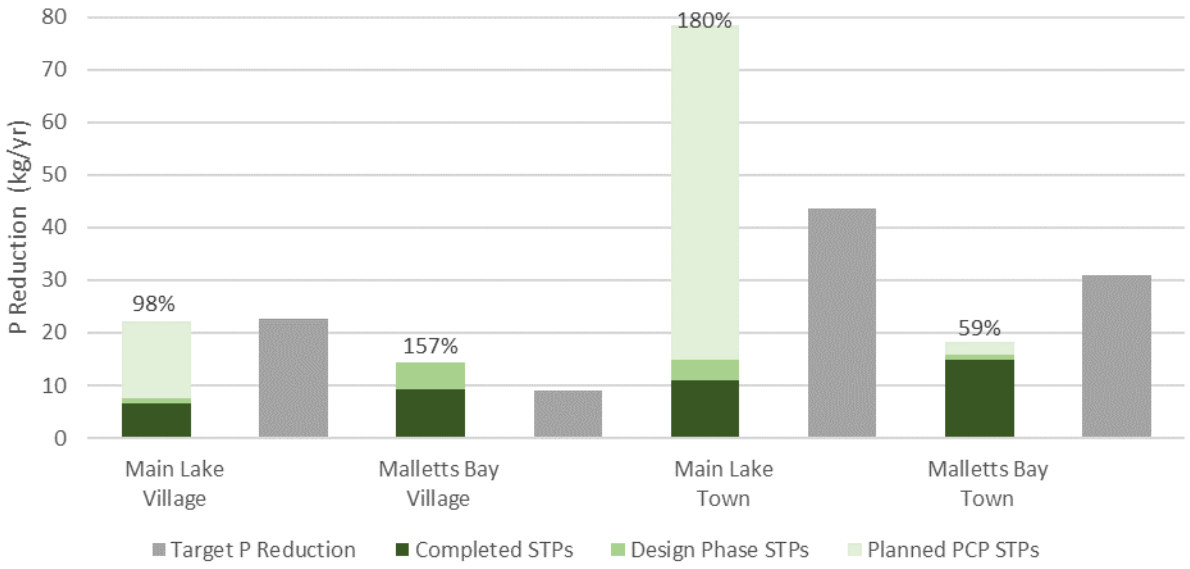


Figure 1. Summary of annual P load reductions from existing, design-phase, and projected structural STPs as compared to required target P reductions (kg/yr). See Tables 2 and 6 for completed STPS; Tables 3 and 7 for design-phase STPs, and Tables 5 and 8 for projected STPs.

3.1. Essex Junction Completed and Design-Phase Structural STPs

A total of eight creditable structural STPs have been completed as of December 2020 (Table 2, Appendix B-1, and Map 2) in the Village, which collectively manage stormwater from a combined 32 acres of impervious area and 58 acres of pervious area. As seen in Table 2 and Figure 1, in the Malletts Bay Lake segment, combined P load reductions from completed projects exceed the P target reduction (9.3 kg/yr or 102% of the total required P reduction). Completed STPs account for 30% of the Village's required P reduction in the Main Lake segment (6.7 kg/yr).

Table 2. Essex Junction Completed Structural STPs

Site Name	Permit No.	Lake Segment	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	P Credit (kg/yr)	% of P Target
Village Walk POI 1	6653-9010	Main Lake	Infiltration Basin	3.32	6.22	26,586	5.11	23%
Village Walk POI 2	6653-9010	Main Lake	Infiltration Basin	0.63	1.23	12,803	0.99	4%
Village Walk POI 3	6653-9010	Main Lake	Infiltration Basin	0.32	0.96	6,849	0.58	3%
		Total Main Lake		**4.27**	**8.41**	**46238**	**6.67**	**30%**
Taft Street S/N 001	6006-9020.1	Malletts Bay	Wet pond/ Wetland	0.48	1.02	3,528	0.22	2%
Taft Street S/N 002	6006-9020.1	Malletts Bay	Wet pond/ Wetland	0.54	0.96	2,090	0.22	2%
Fairview Drive/Main St Gravel Wetland	1-1074 SN 002	Malletts Bay	Gravel Wetland	3.75	18.77	40,800	2.06	23%
Mansfield Brickyard Gravel Wetland	2-0317/2-0952	Malletts Bay	Gravel Wetland	11.39	6.28	70,153	6.08	67%
5 Corners North	4989-INDO	Malletts Bay	Underground Detention	13.89	17.00	11,892	0.72	8%
		Total Malletts Bay		**30.05**	**44.03**	**128,463**	**9.30**	**102%**

Four additional creditable structural STPs are in design phases (Table 3, Appendix B-2, and Map 2) in the Village, which collectively may manage stormwater from a combined 13 acres of impervious area and 19 acres of pervious surface. Since the Village's required P load reduction for the Malletts Bay Lake segment is met primarily through STPs constructed for compliance with the Indian Brook Flow Restoration Plan, the additional practices listed in Table 3 are not further advanced in this PCP. Design-phase STPs are anticipated to account for an additional 4% of the Village's required P reduction in the Main Lake segment (0.9 kg/yr).

Table 3. Essex Junction Design-Phase Structural STPs

Site Name	Permit No.	Lake Segment	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target
Acorn Circle cul-de-sac retrofit - media filter with specialized media		Main Lake	Sand filter (w/ underdrain)	1.10	0.70	3,700	48.2%	0.87	3.85%
Acorn Circle cul-de-sac retrofit - impervious removal		Main Lake	Impervious removal	1.04				0.03	0.13%
Total Main Lake				**2.14**	**0.70**	**3,700**		**0.90**	**3.98%**
Countryside Dr Intersection	2-0155	Malletts Bay	Infiltration Chambers	1.95	3.30	4,792	68.0%	1.12	12%
Grove St.	2-0187	Malletts Bay	Infiltration Chambers	8.71	14.68	2,047	31.2%	2.30	25%
Total Malletts Bay				**10.66**	**17.98**	**6,839**		**3.41**	**37%**

3.2. Essex Junction Projected Structural STPs

Additional structural STP opportunities were screened at the desktop level in the portions of the Village draining directly to the Winooski River, primarily south and southwest of the Five Corners area in residential subdivisions underlain by deep, well-drained and relatively flat Adams and Windsor series loamy sands. The subdivisions hosting these closed drainage systems are well suited to an "invisible green stormwater infrastructure" approach, where retrofits to replace existing catchbasins with drywells, or to add subsurface infiltration chambers as offline treatment for existing catchbasins, would improve water quality while reducing residents' concern about maintenance of vegetated surface green infrastructure practices.

Projected retrofit opportunities were screened first by reviewing the stormwater infrastructure inventory and LiDAR topography with land cover and soil data to identify drainage areas contributing flow to individual catch basins or drainage system outlets as appropriate. The retrofits were further screened for environmental constraints including but not limited to wetlands or wetland buffers; hydric soils; streams, floodplains and river corridors; and rare, threatened, or endangered species. Where possible, retrofit opportunities were sited to minimize conflicts with overhead and underground utilities (including cable/telecom, electric, gas, water, and sewer). Confirmation of the presence of utilities will be required as retrofits conceptually identified in this PCP move forward into design phases.

Almost 40 conceptual structural STP retrofits were identified in the Village's Winooski River direct drainages (Map 2, Appendix B-4, and Appendix B-5). Of these, a substantial opportunity was found at the intersection of South Street and Wilkinson Drive for retrofit of a grass channel with an outlet structure into an infiltration basin or trench with enhanced storage, managing 7.9 acres of impervious for a potential P load reduction of

8.9 kg/yr (EJ-WR-038, Table 5 and Map 2). Of the remaining opportunities, two cul-de-sacs (Loubier Drive and Killoran Drive) contain opportunities to both reduce impervious cover and install subsurface drywells or infiltration practices. Immediately to the south, a similar approach could be applied at the neighborhood scale along Cascadnac, Owaissa, and Wenonah Avenues (Table 5, Map 2). Collectively, these green stormwater infrastructure retrofits would manage at least 13 impervious acres and result in a P load reduction of 14.8 kg P/yr. Projected structural STP retrofits considered, but which were not further advanced, are listed in Appendix B-5.

3.2.1. Structural STP Implementation Cost Estimation

For newly proposed structural STPs in both Essex Junction and Essex Town, implementation costs were estimated using construction costs from recent implementation projects, recent projects completed by consulting team members, unit costs per cubic foot of storage from stormwater retrofits recently completed by the Vermont Agency of Transportation, the EPA's Opti-Tool unit cost estimates, and adjustments to the Opti-Tool[5] unit cost estimates completed for a selection of projects in Vermont and Massachusetts (Table 4). The unit-based implementation costs did not include design and permitting, so a 25% adjustment factor was applied. A factor of 1.25 was additionally applied to the projected unit-based costs to account for the cost differential observed by both MS4s during the implementation of FRP projects.

Table 4. Projected Structural STP implementation unit cost assumptions (2021 dollars)

BMP Type	Unit cost ($/cf)
Bioretention (infiltrating)	$23
Bioretention (w/ underdrain)	$28
Dry Swale (infiltrating)	$17
Dry Swale (w/ underdrain)	$19
Gravel Wetland	$17
Infiltration Basin	$12
Infiltration Chambers	$20
Infiltration Trench	$20
Porous Pavement	$25
Sand filter (infiltrating)	$20
Sand filter (w/ underdrain)	$23

[5] https://www3.epa.gov/region1/npdes/stormwater/ma/green-infrastructure-stormwater-bmp-cost-estimation.pdf

Table 5. Essex Junction Summary of Projected Structural STPs, Main Lake Segment

Unique IDs	Site Name	Year Planned	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target	Cost Estimate ($2021)	$/CF	$/acre impervious managed	$/kg P/yr
EJ-WR-022 EJ-WR-023 EJ-WR-024 EJ-WR-025 EJ-WR-026	Loubier Drive: Drywells or infiltration chambers at existing catch basins; impervious removal in cul de sac.	2027	Infiltration Trench	2.07	3.24	7,071	99.9%	2.37	10.5%	$151,600	$21	$73,237	$63,966
EJ-WR-027 EJ-WR-028 EJ-WR-029 EJ-WR-030	Killoran Drive: Drywells or infiltration chambers at existing catch basins; impervious removal in cul de sac	2029	Infiltration Trench	1.68	1.72	5,821	100.0%	1.81	8.0%	$119,000	$20	$70,833	$65,746
EJ-WR-031 EJ-WR-032 EJ-WR-033 EJ-WR-034 EJ-WR-035 EJ-WR-036 EJ-WR-037	Cascadnac Ave, Owaissa Ave., and Wenonah Ave.: Drywells or infiltration chambers at existing catch basin locations	2032	Infiltration Trench	1.42	1.20	5,910	100.0%	1.60	7.1%	$118,600	$20	$83,521	$74,125
EJ-WR-038	Tyler Drive, Wilkinson Drive - South St. intersection - retrofit/expand	2025	Infiltration Basin	7.86	5.46	28,096	99.8%	8.87	39.3%	$168,600	$6	$21,450	$19,000
TOTALS				**13.03**	**11.62**	**46,898**		**14.65**	**64.9%**	**$557,800**	**$12**	**$42,809**	**$38,066**

3.3. Essex Town Existing and Design-Phase Structural STPs

A total of 10 creditable structural STPs have been completed as of December 2020 (Table 6 and Appendix B-1) in the Town, managing stormwater from a combined 47 acres of impervious area and 81 acres of pervious area. In the Malletts Bay Lake segment, combined P load reductions from completed projects account for 15.0 kg/yr or 48% of the total required P reduction. Completed STPs, primarily constructed to advance completion of the Indian Brook Flow Restoration Plan, account for 25% of the Town's required P reduction in the Main Lake segment (11.0 kg/yr). The list of existing and creditable practices includes infiltration practices on Thompson Drive, where the Town recently received a request to take over operational permit 4181-9015.3 from the permittee. The Town owns the roadway subject to this permit and, pending inspection in the spring of 2021, anticipates incorporating the permit into the Essex Town MS4.

Table 6. Essex Town Completed Structural STPs

Site Name	Permit No.	Lake Segment	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target
Perkins Bend 002	3081-9010.R	Main Lake	Infiltration Chambers	6.00	7.30	1,520	22.4%	1.88	4%
Essex Police Station	7025.9014.ARA	Main Lake	Bioretention (w/ underdrain)	1.14	2.50	3,554	44.4%	0.82	2%
Essex Police Station	7025.9014.ARA	Main Lake	Grass Channel	1.14	2.50	978	5.2%	0.10	0.2%
Kellogg Rd Detention Pond	5944-INDO.R	Main Lake	Wet pond/ Created Wetland	5.77	13.53	170,450	63.0%	7.27	17%
Thompson Drive infiltration - anticipated MS4 transfer in 2021	4181-9015.3	Main Lake	Infiltration Trench	0.80	0.20	2,795	99.8%	0.90	2%
Tanglewood Drive infiltration (Birchwood Manor) -MS4 transfer 2021-2	5263-9015	Main Lake	Bioretention (infiltrating)	1.81	1.0	6,423	97.8	2.00	5%
	Main Lake Total			**16.66**	**27.03**	**185,720**		**12.96**	**30%**
Sydney Drive - Woodlands II-Lang Farm Parcel	1-1186	Malletts Bay	Infiltration Chambers	4.04	28.76	38,812	92.2%	3.39	11%
Essex Town Center- Essex Outlets	4002-INDS.A	Malletts Bay	Wet pond/ Created Wetland	6.45	6.08	28,009	51.9%	0.39	1%
Essex Outlets Pond A	6262-9020	Malletts Bay	Wet pond/ Created Wetland	5.65	9.07	74,139	62.4%	2.98	10%
Essex Outlets Pond B	6262-9020	Malletts Bay	Wet pond/ Created Wetland	3.77	1.22	40,772	0.63	1.97	6%
Essex Outlets Pond C	6262-9020	Malletts Bay	Wet pond/ Created Wetland	11.85	10.30	290,966	63.0%	6.24	20%
	Malletts Bay Total			**31.76**	**55.43**	**472,698**		**14.96**	**48%**

Six additional creditable structural STPs are in design phases (Table 7 and Appendix B-2) in the Town. In the Malletts Bay Lake segment, a pair of STPs associated with the Indian Brook Flow Restoration Plan account for management of 0.9 kg/yr (3%) of the Town's required P reduction. For the Main Lake segment, the Town will gain at least 3.8 kg/yr (0.9% of target) in P reduction from retrofits to two cul-de-sacs that are anticipated to move to construction in 2021-2022.

Table 7. Essex Town Design-Phase Structural STPs

Site Name	Permit No.	Lake Segment	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target
Oakwood Drive cul-de-sac retrofit - media filter with specialized media		Main Lake	Sand filter (w/ underdrain)	2.13	3.68	11,500	54.5%	2.71	1%
Oakwood Drive cul-de-sac retrofit - impervious removal		Main Lake	Impervious removal	2.03				0.14	0.05%
Sage Circle cul-de-sac retrofit - infiltration trenches		Main Lake	Infiltration Trench	0.80	1.30	6,096	100.0%	0.92	0.36%
Sage Circle cul-de-sac retrofit - impervious removal		Main Lake	Impervious removal	0.74				0.06	0.02%
	Main Lake Total			**5.71**	**4.98**	**17,596**		**3.83**	**9%**
Church of Jesus Christ of Latter Day Saints, South Vault	1-1319	Malletts Bay	Sand filter (w/ underdrain)	1.83	0.67	13,286	60.0%	0.91	3%
Church of Jesus Christ of Latter Day Saints, North Vault	1-1319	Malletts Bay	Detention Chambers	---	---	---	---	---	0%
	Malletts Bay Total			**1.83**	**0.67**	**13,286**		**0.91**	**3%**

3.4. Essex Town Projected Structural STPs

In the Essex Town MS4, two substantial STPs are located in the Sunderland Brook watershed and included in that FRP (Outfall 126 and David Drive Outfall) but are not required under that plan (Table 8 and Appendix B-4). While the Outfall 199 retrofit, also identified in that FRP, would move forward only if absolutely necessary, the Outfall 126 and David Drive retrofits represent strong projects that the Town may consider implementing. Coupled with completed and anticipated improvements to hydrologically connected road segments and culvert outlets (Section 4.2), these two structural STP retrofits alone would likely be sufficient to meet target P reductions (Section 7).

In the event that the Town chooses not to prioritize additional structural STPs in the Sunderland Brook watershed, and in order to provide flexibility to the Town in meeting MS4 target P reductions, additional BMP identification was conducted as described below.

The Essex Town MS4 has incorporated over 40 operational permits into its MS4 permit. Most of the STPs included in these permits were constructed before the 2010 base monitoring period for the Lake Champlain P TMDL and thus are not presently eligible for P reduction credit – and many are located in the Malletts Bay Lake segment. However, for those in the Alder Brook and direct Winooski watersheds, they represent

opportunities for strategic retrofit to achieve compliance with the MS4's P reduction obligations under the Essex Town PCP. While many of the incorporated permits include only closed drainage systems to outlets or grass channels, three sites were selected for further review in consultation with the Town (Appendix B-3 and Appendix B-4):

- Convert existing wet pond at Autumn Knoll (4367-9010.R) into a gravel wetland and maintain existing pond's extended detention.
  - The retrofit is located in the Mallets Bay Lake segment (draining to the Browns River and ultimately the Lamoille River). The concept appears feasible and represents a P reduction of approximately 2.4 kg/yr. This opportunity was included in the projected list of structural STPs (EX-LR-001, Table 8).
- Convert existing grass swales in the Old Stage Village Development (3579-9010.R) into dry swales.
  - While maintenance of the existing swales is needed, the soils appear to have limited suitability for infiltration compared to other areas in Town, and open space for construction of STPs outside of the existing grass channels is limited (Appendix B-5).
- Convert existing wet pond at Meadows Edge (3324-9010.R) into a gravel wetland.
  - This concept appears feasible and represents a substantial P reduction (approximately 9 kg/yr). This retrofit opportunity was included in the projected list of structural STPs (EX-WR-001, Table 8).
- Convert existing dry extended detention pond at Craftsbury Court (3581-9010.R) to a gravel wetland, maintaining the existing basin's storage volume.
  - This concept appears feasible and represents a reasonable P reduction (approximately2.8 kg/yr). The retrofit opportunity was included in the projected list of structural STPs (EX-WR-040, Table 8).

Additional structural STP opportunities were screened in the Main Lake segment at the desktop level, focusing on areas where closed drainage system outlets were identified as Not Meeting Standards through the 2017 REI (Section 4.2). In many cases, the subdivisions hosting these closed drainage systems were constructed on highly infiltrative and highly erodible soils, such that focused retrofits to replace existing catchbasins with drywells, or to add subsurface infiltration chambers as offline infiltration practices for existing catchbasins, would both improve water quality and reduce downstream flow and velocity at the drainage system outlets. Eleven such opportunities were identified in the Alder Brook watershed and in Winooski River direct drainages along Foster Road, Saxonhollow Road and Hillside Avenue, Sand Hill Road, Greenbriar Drive and Greenfield Road, and Wildwood Drive (Table 8, Map 2). Three opportunities were identified along Logwood Circle, where video inspection of the stormline network identified five lines in need of replacement. In this instance, the stormlines could be replaced with perforated HDPE in stone bedding to effectively function as infiltration trenches, and if feasible or desired, the associated catchbasins could be replaced with drywells. Collectively, these green stormwater infrastructure retrofits would manage at least 26 impervious acres and result in a P load reduction of 29.8 kg P/yr.

Table 8. Essex Town, Summary of Projected Structural STPs

ID	Site Name	Year Planned	Lake Segment	BMP Type	Impervious (acres)	Pervious (acres)	Storage volume (ft^3)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target	Estimated Cost ($2021)	$/CF	$/acre impervious	$/kg P/yr
EX-LR-001	Autumn Knoll S/N 001 RETROFIT	2032?	Malletts Bay	Gravel Wetland	3.03	3.91	10,081	54.7%	2.38	5%	$171,400	$17	$56,568	$72,017
Outfall 126	Outfall 126	2027?	Main Lake	Infiltration Basin	9.84	10.58	41,600	97.6%	13.11	30%	$415,300	$10	$42,205	$31,683
1-0896, 1-0552, 1-1463	David Drive Outfall	2035?	Main Lake	Infiltration Chambers	15.96	16.25	61,028	96.5%	20.82	48%	$852,200	$14	$53,396	$40,931
EX-WR-001	Meadows Edge/Steeplebush RETROFIT	2028	Main Lake	Gravel Wetland	6.59	61.50	21,711	42.2%	9.10	21%	$369,100	$17	$56,009	$40,549
EX-WR-002	CB772-775 Foster Rd drywells	2034	Main Lake	Infiltration Trench	1.34	2.42	4,559	99.5%	1.54	4%	$91,200	$20	$68,060	$59,329
EX-WR-003 EX-WR-004 EX-WR-005 EX-WR-006 EX-WR-007	Saxonhollow and Hillside Ave: Drywells or infiltration chambers	2029	Main Lake	Infiltration Trench	2.86	5.75	10,251	99.6%	3.29	8%	$205,300	$20	$71,783	$62,401
EX-WR-008	Sand Hill Rd drywells	2032	Main Lake	Infiltration Trench	0.87	2.49	3,024	99.5%	1.02	2%	$60,500	$20	$69,540	$59,539
EX-WR-009	Greenbriar Dr drywells	2032	Main Lake	Infiltration Trench	0.77	1.22	2,697	99.6%	0.88	2%	$54,400	$20	$70,649	$61,732
EX-WR-010	Greenfield Rd drywells	2032	Main Lake	Infiltration Trench	1.09	2.53	3,743	93.5%	1.74	4%	$74,900	$20	$68,716	$43,050
EX-WR-011 EX-WR-012	Wildwood: Drywells or chambers	2032	Main Lake	Infiltration Trench	0.47	0.90	1,882	96.1%	0.70	2%	$38,000	$20	$80,851	$54,286
EX-WR-039	Tanglewood Dr. & Fern Hollow (Alternative 4)	2026	Main Lake	Dry Swale (w/ underdrain)	6.66	11.50	18,774	44.0%	4.44	10%	$410,000	$22	$61,565	$92,302
EX-WR-040	Craftsbury Court pond retrofit	2034?	Main Lake	Gravel Wetland	2.55	7.31	20,100	63.0%	2.81	6%	$341,700	$17	$134,000	$121,678
EX-WR-041 EX-WR-042 EX-WR-043	Logwood Circle: Storm line replacements	2028	Main Lake	Infiltration Trench	3.53	10.35	13,932	97.9%	4.23	10%	$278,600	$20	$78,924	$65,863
MAIN LAKE TOTALS					**52.53**	**132.80**	**203,301**		**63.68**	**146%**	**$3,191,200**	**$16**	**$60,750**	**$50,116**

4. Municipal Hydrologically Connected Road Segments

The Municipal Roads Requirements outlined in Section 8.3 of the MS4 Permit[1] reflect those of the Municipal Roads General Permit[6] (MRGP), which require municipalities to implement a long-term plan to improve hydrologically connected road drainage systems to a set of standards included in the Permit. MS4s were required to conduct a Road Erosion Inventory (REI) and Implementation Table for all municipal hydrologically connected road segments by April 1, 2020. The REI was used to determine if road segments met the standards of Section 8.3.C of the MS4 Permit, while the Implementation Table is used to prioritize improvement of road segments that need to be brought up to standards. The results of the Essex Village/Town REI can be found on the MRGP Implementation Table Portal,[7] and the results summarized in this section were obtained from the Chittenden County Regional Planning Commission in October 2020.

The improvements required to bring a road segment up to standards vary based on road category but can involve BMPs such as stabilizing ditches with vegetation/stone, installing turn outs and/or stabilizing erosion at culvert outlets. The ANR has defined P crediting methodologies in a draft Tracking and Accounting SOP[8], which are based on pre- and post-construction road conditions as well as road typology (paved and unpaved roads with ditches, paved roads with catch basin outlets, and Class 4 roads). While standards and crediting for paved and unpaved roads with ditches and Class 4 roads are applied at the road segment level, the standards and crediting for paved roads with catch basins are derived from the volume of erosion stabilized at drainage system outlets(Appendix C) .

Both Essex Junction's and Essex Town's MS4s have been proactively completing improvements to bring road segments up to standards and stabilize erosion at outlets since the latest MS4 Permit became effective in 2018. As required by the MS4 Permit, the remaining road segments that Do Not Meet or Partially Meet standards must be brought up to standards, with the highest-priority improvements to be completed within the current permit term. Hydrologically connected municipal road segment and outlet improvements completed through December 2020 or anticipated in the Essex Junction MS4 (Figure 2) account for up to 27% (2.6 kg/yr) of annual P load reduction in the Malletts Bay Lake segment where the P reduction target is already met, but only a small proportion of the P load reduction needed in the Village's Main Lake segment. In contrast, completed and remaining road segment repairs and outlet stabilization measures in the Essex Town MS4 may account for 42% (16.6 kg/yr) of the target P reduction in the Malletts Bay lake segment, and 11% (4.6 kg/yr) in the Main Lake segment. The P credit gained from completed roadway improvements, and anticipated P reductions from planned improvements as identified in the REI and Implementation Tables, are summarized below for both MS4s.

[6] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Permitinformation/MunicipalRoads/sw_FinalMRGP.pdf
7 https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=True&Report=Portal
[8] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/FINAL%20DRAFT%20MRGP%20SOP%206-5-20.pdf

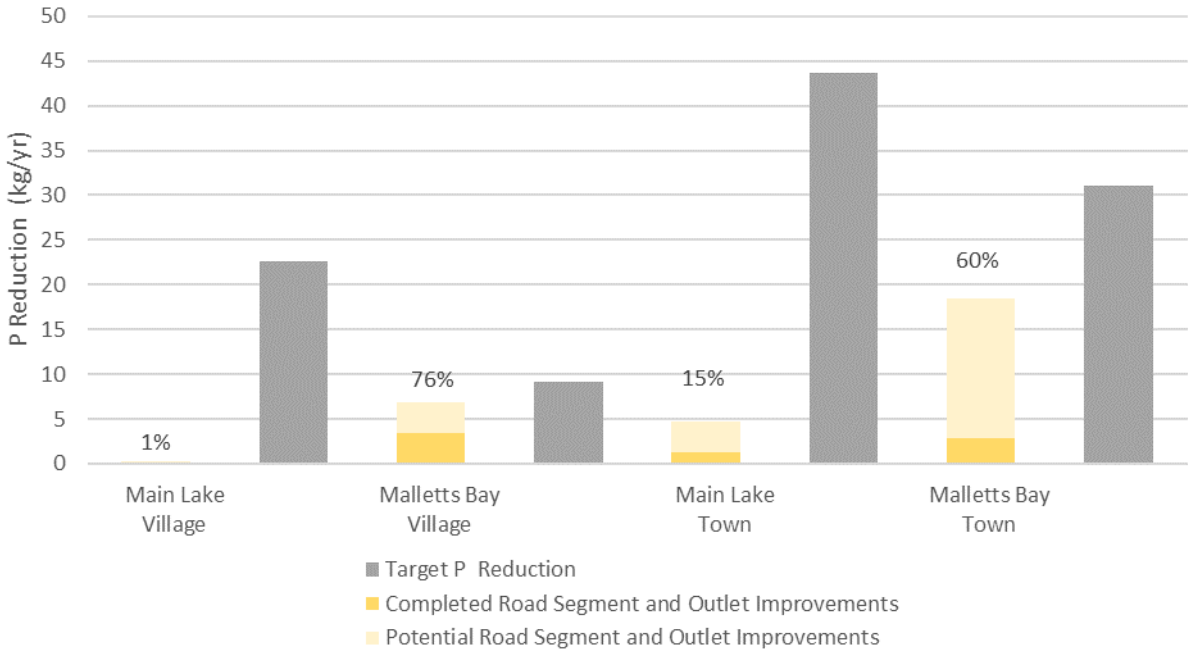


Figure 2. Essex Junction and Essex Town, total P reduction from existing and remaining outlet and road segment improvements as compared to required total P reduction (kg/yr). See Table 15 for Essex Junction summary and Table 22 for Essex Town summary.

Cost Estimation for Improvements to Bring Hydrologically Connected Road Segments and Outlets Up to Standards

For road segments and closed drainage outlets where improvements are required to come into compliance with MRGP standards, implementation costs were estimated using construction costs from recent projects completed by both MS4s, recent projects completed by consulting team members, and unit costs per road segment and outlet drawn from a review of Municipal Roads Grants-in-Aid data completed for the project *Cost Effectiveness and Operation & Maintenance Standards of Clean Water Projects in Vermont*, where final outputs were submitted to Vermont DEC in March 2021.

For paved roads with ditches, gravel roads, and Class 4 roads, planning level estimates of the estimated cost to bring each road segment up to standards were calculated on a per-road-segment basis using median cost to bring road segments partially or fully up to standards (Table 9). For paved roads with catch basins to outlets, improvement costs were estimated on a per-outlet basis using the median cost of outlet improvement projects completed by the Village and Town to date, after including a 25% contingency (Table 10). Outlets that were determined to be partially meeting standards were estimated at 50% of the median outlet repair cost. Additional unit cost estimation resources for common crown, shoulder, ditch, and culvert improvements are presented in Table 11.

For both road segment and outlet improvements, costs presented in this PCP should be considered order-of-magnitude estimates. The Essex Town MS4 will complete a 10-year Gravel Road Stormwater Management Plan in 2021-2022, which will become part of this PCP upon completion and adoption by the Town. Furthermore, the repairs needed to bring closed drainage and culvert outlets up to standards are extremely variable, depending upon the unique conditions of each closed drainage system and outlet.

Table 9. Summary of Costs ($2021) to Improve Road Segments, Municipal Roads Grants-in-Aid Review

Municipal Roads Grants-in-Aid Summary Statistic	Partially Meets	Does Not Meet
Class 3 Mean Improvement Cost per 100 m	$4,200	$5,600
Class 3 Median Improvement Cost per 100 m	$3,800	$4,300
Class 3 Mean Improvement Cost per mile	$67,600	$88,800
Class 3 Median Improvement Cost per mile	$61,000	$67,700

Table 10. Summary of Recent Essex Junction and Essex Town Paved Road-Catch Basin Outlet Stabilization Cost

Project Name	$/project	Project Cost +25% Contingency
Town - Saybrook Road Outlet (Town provided some material)	$3,974	$4,970
Town - Bobolink Circle Outlet	$5,744	$7,180
Village-Juniper Ridge Rd Outlet	$7,509	$9,390
Village-Corduroy Rd Outlets 1090 & 1091	$7,987	$9,990
Village-Corduroy Rd Outlet 1094	$18,020	$22,530
Village-40 Beech St	$11,480	$14,350
Average Project Cost	$9,119	$11,400
Median Project Cost	**$7,800**	**$9,800**

Table 11. Unit Cost Resources for Common MRGP Practices

Practice	Units	2017 $	2021 $
Crowning Road	LF	$5	$6
Culvert Headwall / Armor	each	$300	$320
Culvert Turnout	each	$200	$210
Drainage Culvert	each	$1,500	$1,570
Driveway Culvert	each	$750	$790
Grass-lined Ditch	LF	$8	$9
Removing Grader Berm	LF	$5	$6
Stone-Lined Ditch	LF	$25	$27

2021 unit costs assume an annual inflation rate of 1.5% and 4 elapsed calendar years (2017-2021)
Source: Fitzgerald Environmental Associates and Milone & Macbroom, submitted to CCRPC and the Town of Jericho, 2017.

4.1. Essex Junction Completed and Planned Improvements to Bring Hydrologically Connected Road Segments up to Standards

Of the 39 km (386 road segments) of hydrologically connected roadway in Essex Junction, approximately 10.9 km (109 segments) were initially identified as Not Meeting Standards in the 2017 REI. Most of these road segments are paved roads with catch basins associated with 12 culvert outlets (Table 12, Table 13, and Map 2).

Since completing the 2017 REI, the Essex Junction MS4 has proactively implemented roadway improvements[9] including the stabilization of six eroding outlets along paved roadway with curbs (Table 12). Most of these improvements are tracked correctly in the MRGP datasets, but in the case of improvements completed on Fairview Drive in 2019, outlets EJCT038 and EJCT039 were found to be reversed in the inventory. EJCT038 had no erosion, while EJCT039 had gully erosion and did not meet standards. EJCT039 was repaired in 2019 as part of the Fairview Gravel wetland project. Additionally, Outlet 1094 off Corduroy Road was stabilized in October 2020 (Better Roads grant 0670). This outlet does not appear in the REI outlets dataset, but the field work conducted in completing this repair verified its hydrologic connectivity. The repair stabilized 49 cubic yards of erosion, resulting in an estimated P load reduction of 0.76 kg/yr that is included in Table 12 and Table 15. *This outlet, which is related to road segments 7030_CORDUROY_RD_13208.1 and 7030_MASON_DR_38565.1, should be added to the MRGP inventory of hydrologically connected outlets.*

Table 12. Summary of hydrologically connected Paved-Curbed road segments and outlets with stabilization measures implemented, Essex Junction

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Jct)	Road Name	Total Road Segments	Erosion Volume Managed (yd³)	Estimated P Load Reduction (kg/yr)
Malletts Bay	EJCT039	1OLET1158	FAIRVIEW DR	1	38	0.59
	EJCT045	1OLET1154	JUNIPER RIDGE RD	2	85	1.31
			SYCAMORE LN	1		
	EJCT050	1OLET1134	ASPEN DR	2	24	0.37
			BEECH ST	6		
			COUNTRYSIDE DR	2		
			TAMARACK DR	2		
	EJCT056	1OLET1090	CORDUROY RD	2	12	0.19
	EJCT057	1OLET1091	CORDUROY RD	1	12	0.19
	NONE	1OLET1094	CORDUROY RD	1	49	0.76
Total	*6*			*20*	*220*	*3.40*

Table 13. Summary of hydrologically connected paved road segments and outlets with stabilization measures needed, Essex Junction

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Jct)	Road Name	Segments Not Meeting Standards	Segments Partially Meeting Standards	Erosion Volume to be Managed (yd³)	Estimated P Load Reduction (kg/yr)
Malletts Bay	EJCT015	1OLET1146	GROVE ST	0	1		
	EJCT034	1OLET1149	ATHENS DR	2	0	43	0.66
	EJCT055	1OLET1085	BRICKYARD RD	0	1	3.3	0.05
	EJCT065	1OLET1074	ROSEWOOD LN	1	0	178	2.75
	EJCT066	1OLET1073	BRIAR LN	1	0	6.7	0.10
			ROSEWOOD LN	2	0		
	Total			*6*	*2*	*227.2*	*3.51*
Main Lake	EJCT076	1OLET1117	WOODS END DR	1	0	12.4	0.19
	EJCT090	1OLET1023	SILVER BOW TERR	1	0	6.1	0.09
	Total			*2*	*0*	*18.5*	*0.28*

[9]https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=True&Report=Inventory&MunicipalityID=280#P5a6f3051a3aa40128ed161e0af21948d_3_76iT0

The completed outlet repairs resulted in an estimated 220 cubic yards of erosion managed and 3.4 kg/yr of P reduction, all within the Malletts Bay Lake segment (Table 12). Bringing the remaining culvert outlets and thus the associated road segments up to standards, as required by the MS4 Permit, will result in an additional 3.8 kg/yr reduction in P and 246 cubic yards of erosion stabilization at outlets on paved roads with and without curbs (Table 13), at an estimated implementation cost of $53,900 (Table 14). The total estimated P reduction for existing and planned roadway improvements in Essex Junction is 0.3 kg/yr (1%) and 6.9 kg/yr (76%) for the Main Lake and Malletts Bay Lake Segments, respectively (Table 15).

Table 14. Estimated Implementation Costs for Catch Basin Outlet Stabilization, Essex Junction

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Jct)	Road Name	Estimated Outlet Stabilization Cost ($2021)
Malletts Bay	EJCT015	1OLET1146	GROVE ST	$4,900
	EJCT034	1OLET1149	ATHENS DR	$9,800
	EJCT055	1OLET1085	BRICKYARD RD	$4,900
	EJCT065	1OLET1074	ROSEWOOD LN	$9,800
	EJCT066	1OLET1073	BRIAR LN ROSEWOOD LN	$9,800
	Total			*$39,200*
Main Lake	EJCT076	1OLET1117	WOODS END DR	$9,800
	EJCT090	1OLET1023	SILVER BOW TERR	$4,500
	Total			*$14,700*
TOTAL OUTLET STABILIZATION COST				*$53,900*

Table 15. Essex Junction total P reductions from existing and planned hydrologically connected roadway brought up to standards, paved-curbed road segments and related outlet stabilization (kg/yr)

Lake Segment	Competed Outlet Stabilization P Reduction	Planned Outlet Stabilization P Reduction	Total Outlet Stabilization P Reduction	Target P Reduction	% of Total P Reduction
Main Lake	0.0	0.3	0.3	22.6	1.3%
Malletts Bay	3.4	3.5	6.9	9.1	75.8%
Total	*3.4*	*3.8*	*7.2*	*31.7*	22.4%

4.2. Essex Town Completed and Planned Improvements to Bring Hydrologically Connected Road Segments up to Standards

Of the 57.9 km of hydrologically connected roadway in the Essex Town MS4, 9.8 km were required to be brought up to standards in the initial 2017 REI. In Essex Town, a smaller proportion of these road segments (23 in total) are paved roads with catch basins associated with 12 culvert outlets (Table 17 and Appendix C).

Since completing the 2017 REI, the Essex Town MS4 has prioritized bringing Class 4 and gravel road segments up to standards[10], rather than focusing on outlet rehabilitation. Outlet 2OLET065 off Bobolink Circle was stabilized in 2019, resulting in an estimated P load reduction of 1.33 kg/yr (Table 16). Completing repairs at the remaining identified culvert outlets, and thus bringing the associated road segments up to standards as required by the MS4 Permit, will result in an estimated 178 cubic yards of erosion stabilization

[10]https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=True&Report=Inventory&MunicipalityID=69#Pb451ab527ee947e89f437b4a19576123_2_40iT0

and an estimated 1.71 kg/yr P load reduction at outlets on paved roads with curbs (Table 17), at an estimated implementation cost of $93,100 (Table 18).

Table 16. Summary of hydrologically connected Paved-Curbed road segments and outlets with stabilization measures implemented, Essex Town

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Jct)	Road Name	Total Road Segments	Erosion Volume Managed (yd^3)	Estimated P Load Reduction (kg/yr)
Main Lake	ESSX026	2OLET065	BOBOLINK CIR	1	86.0	1.33
Total	*1*			*1*	*86.0*	*1.33*

Table 17. Summary of hydrologically connected paved road segments and outlets with stabilization measures needed, Essex Town

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Town)	Road Name	Segments Not Meeting Standards	Segments Partially Meeting Standards	Erosion Volume to be Managed (yd^3)	Estimated P Load Reduction (kg/yr)
Malletts Bay	ESSX022	2OLET239	WHITCOMB MEADOWS LN	0	1	1.0	0.20
	ESSX053	2OLET068	CIRCLE DR	2	0	15.0	0.23
	Total	*2*		*2*	*1*	*16.0*	*0.43*
Main Lake	ESSX031	2OLET150	WINDRIDGE RD	1	0	9.0	0.14
	ESSX035	2OLET153	WILDWOOD DR	1	0	4.0	0.06
	ESSX036	2OLET152	WILDWOOD DR	0	1	2.0	0.03
	ESSX042	2OLET186	GREENBRIAR DR	0	1	2.0	0.03
	ESSX043	2OLET135	SAND HILL RD	1	0	10.0	0.15
	ESSX051	2OLET187	FOSTER RD	3	0	8.0	0.12
	ESSX056	2OLET171	PINEWOOD DR	0	1	1.0	0.02
	ESSX062	2OLET112	SAXONHOLLOW	5	0	UNKNOWN	
			HILLSIDE AVE	3	0		
	ESSX064	2OLET118	GREENFIELD CT	1	0	45.0	0.70
			GREENFIELD RD	2	0		
	ESSX066	2OLET172	HEATHERBUSH RD	0	2	2.0	0.03
			PINEWOOD DR	0	1		
			VALLEYVIEW DR	0	4		
	Total	*12*		*18*	*10*	*162.0*	*1.28*

Table 18. Estimated Implementation Costs for Catch Basin Outlet Stabilization, Essex Town

Lake Segment	Outlet ID (REI)	Outlet ID (Essex Town)	Road Name	Estimated Outlet Stabilization Cost ($2021)
Malletts Bay	ESSX022	2OLET239	WHITCOMB MEADOWS LN	$4,900
	ESSX053	2OLET068	CIRCLE DR	$9,800
	Total	*2*		*$14,700*
Main Lake	ESSX031	2OLET150	WINDRIDGE RD	$9,800
	ESSX035	2OLET153	WILDWOOD DR	$9,800
	ESSX036	2OLET152	WILDWOOD DR	$4,900
	ESSX042	2OLET186	GREENBRIAR DR	$4,900
	ESSX043	2OLET135	SAND HILL RD	$9,800
	ESSX051	2OLET187	FOSTER RD	$9,800
	ESSX056	2OLET171	PINEWOOD DR	$4,900
	ESSX062	2OLET112	SAXONHOLLOW	$9,800
			HILLSIDE AVE	
	ESSX064	2OLET118	GREENFIELD CT	$9,800
			GREENFIELD RD	
	ESSX066	2OLET172	HEATHERBUSH RD	$4,900
			PINEWOOD DR	
			VALLEYVIEW DR	
	Total	*12*		*$78,400*
TOTAL OUTLET STABILIZATION COST				*$93,100*

Since completing the 2017 REI, the Town has implemented improvements to bring one Class 4 road up to standards (ID 7030_W_Sleepy_Hollow_Rd_5), for a P load reduction of 0.25 kg/yr (Table 19). The erosion volume corrected for this road segment was estimated at approximately 6 CY, so a 40% P reduction was applied consistent with the draft MRGP Tracking and Accounting SOP. However, the erosion was repaired using MRGP practices, including a new stone-lined ditch on the one side of the road, re-establishment and stone-lining of the existing ditch, creation of two separate stone turnouts, and replacement of an existing 15" driveway culvert with a new 18" culvert. While the Town is not legally obligated to maintain Class 4 roads, the Essex Town MS4 realizes that only stabilizing gully erosion on Class 4 roads is often not sufficient when erosion is tied to the road's drainage. In order to properly mitigate the erosion, a suite of appropriate MRGP BMPs were required and were implemented. Further discussion of the appropriateness of P crediting with the Stormwater Program may be warranted, particularly if other MS4 and MRGP permittees are encountering similar issues with erosion mitigation on Class 4 roads.

Since the 2017 REI was completed, Essex Town has also brought 14 gravel road segments (on Brigham Hill and Osgood Hill Roads) up to standards[11], yielding a P reduction of 2.7 kg/yr (Table 19).

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https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=True&Report=Inventory&MunicipalityID=69#Pb451ab527ee947e89f437b4a19576123_2_40iT0

Table 19. Essex Town summary of completed road segment improvements by road type

Lake Segment	Road Segments Managed by Roadway Type			Total Road Segments	Segment P Reduction by Road Type			Total P Load Reduction	% of Total P Reduction
	Class 4	Gravel	Paved - Non Curbed		Class 4	Gravel	Paved - Non Curbed		
Main Lake	0	0	0	0	0.00	0.00	0.00	0.00	0.0%
Malletts Bay	1	14	0	15	0.25	2.67	0.00	2.92	9.4%
Total	*1*	*14*	*0*	*15*	*0.25*	*2.67*	*0.00*	*2.92*	

Bringing the remaining gravel and paved, uncurbed road segments up to standards may result in an additional 17.3 kg/yr P load reduction from 62 road segments, primarily located in the Malletts Bay Lake segment (Table 20). Implementation costs for these improvements are estimated to be approximately $245,100 (Table 21).

The total estimated P reduction for existing and planned roadway improvements in the Town is 2.1 kg/yr (5%) for the Main Lake segment and 18.1 kg/yr (58%) for the Malletts Bay Lake segments, respectively (Table 22).

In 2021, Essex Town will complete road segment improvements at Catella Road, Hanley Lane, and Osgood Hill Road. The MS4 will also begin the preparation of a 10-year MRGP Improvement Plan, which is anticipated to be completed in 2022 and which will provide refined prioritization and customized unit-cost-based estimates for completing the remaining road segment improvements.

Table 20. Essex Town summary of remaining road segment improvements and P Load reductions by road type

Lake Segment	Road Name	Segments Managed by Roadway Type		Segment P Reduction by Road Type (kg/yr)		Total P Load Reduction	Target P Reduction	% of Total P Reduction
		Gravel	Paved - Non Curbed	Gravel	Paved - Non Curbed			
Malletts Bay	BRIGHAM HILL LN	5		1.38		15.14	31.0	49%
	CATELLA RD	9		2.15				
	CURVE HILL RD	1		0.11				
	DISCOVERY RD	3		0.61				
	ESSEX HIGHLANDS		1		0.39			
	HANLEY LN	3		0.34				
	INDIAN BROOK RD	4		1.19				
	LOST NATION RD	16		5.49				
	NAYLOR RD	1		0.11				
	OLD PUMP RD	3		0.86				
	OSGOOD HILL RD	6		1.20				
	SAWMILL RD	1		1.21				
	SUSIE WILSON BYP		1		0.11			
	Total	*52*	*2*	*14.65*	*0.49*			
Main Lake	BRIGHAM HILL LN	3		0.63		2.12	43.6	5%
	BRIGHAM HILL RD	3		0.91				
	COLONEL PAGE RD	1		0.12				
	OLD STAGE RD		1		0.46			
	Total	*7*	*1*	*1.66*	*0.46*			

Table 21. Estimated Implementation Costs for Hydrologically Connected Road Segment Improvements, Essex Town

Lake Segment	Road Name	Segments Managed by Roadway Type		Estimated Road Segment Improvement Cost ($2021)
		Gravel	Paved - Non Curbed	
Malletts Bay	BRIGHAM HILL LN	5		$34,700
	CATELLA RD	9		$4,300
	CURVE HILL RD	1		$11,400
	DISCOVERY RD	3		$3,800
	ESSEX HIGHLANDS		1	$11,900
	HANLEY LN	3		$23,800
	INDIAN BROOK RD	4		$4,300
	LOST NATION RD	16		$119,000
	NAYLOR RD	1		$20,000
	OLD PUMP RD	3		$3,800
	OSGOOD HILL RD	6		$11,400
	SAWMILL RD	1		$16,700
	SUSIE WILSON BYP		1	$63,300
	Total	*52*	*2*	*$213,200*
Main Lake	BRIGHAM HILL LN	3		$11,400
	BRIGHAM HILL RD	3		$12,400
	COLONEL PAGE RD	1		$3,800
	OLD STAGE RD		1	$4,300
	Total	*7*	*1*	*$31,900*
TOTAL ROAD SEGMENT IMPROVEMENT COST				*$245,100*

Table 22. Essex Town P load reductions from existing and remaining hydrologically connected road segments by road type (kg/yr)

Lake Segment	Segment P Reduction by Road Type				Total P Load Reduction	Target P Reduction	% of Total P Reduction
	Class 4	Gravel	Paved - Non Curbed	Paved-Curbed			
Segments Improved to Meet Standards							
Main Lake	0.00	0.00	0.00	1.33	1.33	43.6	3.1%
Malletts Bay	0.25	2.67	0.00	0.00	2.92	31.0	9.4%
Segments Not or Partially Meeting Standards							
Main Lake	0.00	1.66	0.46	2.50	4.62	43.6	10.6%
Malletts Bay	0.00	14.65	0.49	0.43	15.57	31.0	50.2%
Combined Improvement Summary							
Main Lake	0.00	1.66	0.46	3.83	4.62	43.6	13.7%
Malletts Bay	0.25	17.32	0.49	0.43	18.49	31.0	59.6%
Total	*0.25*	*18.98*	*0.95*	*4.26*	*23.11*	*74.6*	

5. Non-Structural Controls

The Village and Town share equipment to conduct a non-structural program that includes street sweeping and catch basin cleaning for a total of 134 ac of impervious roadway in the Town and 112 ac in the Village. A 2013 vacuum sweeper sweeps streets twice per year during the fall months, and main travel routes in the Village are swept three to four times per year. A vactor is shared, and catch basins are cleaned once every four years in the Town and once every two years in the Village.

To determine the benefit of current and potential adjustment to future non-structural controls, Essex Village/Town participated in a regional study with the United States Geological Services (USGS) in cooperation with CCRPC, DEC, and several additional partners[12]. Draft results of the study were provided by DEC in June 2020, and detail on the street sweeping credit calculations in the study were provided by DEC staff in October-November 2020. Stone conducted additional quality control checks and expanded the calculations for current practices to include all sweeping activities regardless of tree cover. The annual P load reductions achieved by current non-structural controls, and those possible through enhanced street sweeping measures, are summarized in Figure 3 and further described below.

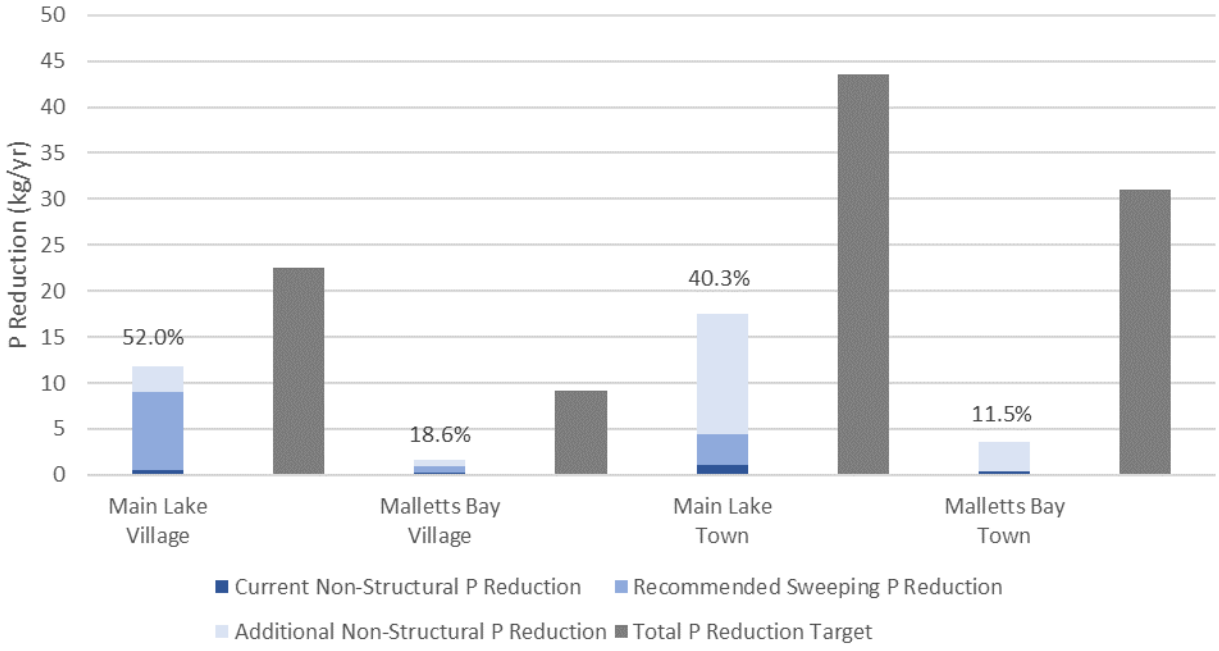


Figure 3. Essex Junction and Essex Town, annual P reduction from current, recommended, and potential additional non-structural controls (kg/yr). Table 33 contains a summary. See Tables 23, 24, and 27 for Essex Junction, and Tables 28, 29, and 32 for Essex Town.

[12] https://www.usgs.gov/centers/new-england-water/science/nutrient-and-sediment-load-reduction-estimates-intensive-street?qt-science_center_objects=0#qt-science_center_objects

5.1. Essex Junction Non-Structural Controls

The Village achieves a 0.7 kg/yr reduction from current street sweeping and catch basin cleaning practices (Table 23). If the MS4 were to adopt the Wisconsin Department of Natural Resources' methodology of leaf management (sweeping streets with >17% tree cover four times in the fall with any sweeper technology), and VTDEC continues to accept this currently-draft crediting method, the Village could achieve an additional 12.8 kg/yr P reduction (Table 24, Figure 3).

Table 23. Essex Junction total P reductions from current non-structural practices

Lake Segment	Catch Basin Cleaning P Reduction (kg/yr)	Sweeping P Reduction (kg/yr)	Total P Reduction (kg/yr)	Target P Load Reduction (kg/yr)	% of Total P Reduction
Main Lake	0.30	0.15	0.46	22.60	2.0%
Malletts Bay	0.15	0.07	0.22	9.10	2.4%
Total	*0.45*	*0.23*	*0.68*	*31.70*	*2.1%*

Note: Current non-structural controls in Village of Essex Junction include sweeping routes 2 times per year (spring and fall), vacuum assisted. 2% maximum reduction credit, discounted 90% to account for 2000 start of present sweeping regime. Catch basin cleaning occurs once every two years, as inspections warrant.

Table 24. Essex Junction potential additional P reductions from WI-based non-structural practices

Lake Segment	Additional Sweeping P Reduction (kg/yr)	Target P Load Reduction (kg/yr)	% of Total P Reduction
Main Lake	11.28	22.60	49.9%
Malletts Bay	1.48	9.10	16.2%
Total	*12.76*	*31.70*	40.2%

Note: Assumes sweeping routes with >17% tree cover 4 times in the fall, any technology. 17% P reduction efficiency. P reduction for current activities is subtracted. Only the Green and Blue sweeping routes are eligible. No change is forecast for catch basin cleaning, assumed it occurs once every two years as inspections warrant.

Sweeping data for 2020 activity were further assessed by sweeping route to provide guidance for future enhancements if desired by Essex Junction. Of the five routes assessed in the Clean Streets study, the Blue route, located in the Main Lake segment, was the largest route with tree cover <17% assessed in terms of road miles (Appendix D and Table 25). The Blue route was the route swept most frequently in 2020, accruing the greatest P credit (Table 26). Future enhancements to sweeping frequency should be targeted to the Blue route, where a P reduction of 8.6 kg/yr may be achieved through enhanced fall sweeping (Table 27).

Table 25. Essex Junction, Road Miles and Paved Road Area by Lake Segment and Sweeping Route

	Road Miles			Paved Road Area (acres)		
Route	Watershed divide	Main Lake	Malletts Bay	Watershed divide	Main Lake	Malletts Bay
Blue		30.43			62.7	
Dark green		3.32			6.8	
Dark/Light Green	1.31			1.25		
Light Green			5.23			10.78
Pink		11.24			26.16	
Pink/Red	6.54			3.05		
Red			18.95			39.05
Total	*7.85*	*44.99*	*24.18*	*4.30*	*95.66*	*49.83*

Table 26. Essex Junction, Summary of P Reduction Credit for Sweeping by Route, 2020 data

Route	Main Lake (kg/yr)	Malletts Bay (kg/yr)
Blue	0.95	
Dark green	0.10	
Light Green		0.14
Pink	0.31	
Red		0.50
Total	*1.37*	*0.64*

Table 27.Essex Junction, Summary of Estimated P Reduction Possible Through Application of Wisconsin Sweeping Methodology

Route	Main Lake (kg/yr)	Malletts Bay (kg/yr)
Blue	8.55	
Dark green	0.93	
Light Green		1.24
Total	*9.48*	*1.24*

Note: Estimated P reduction approximated assuming two lane widths of 8.5 ft. swept per street to convert road miles to acres. This results in a slightly lower estimated P load, and thus P credit, compared to the high-level summary values provided in Table 24.

5.2. Essex Town Phosphorus Reduction Benefits of Non-structural Controls

The Town achieves a 1.4 kg/yr P reduction from current street sweeping and catch basin cleaning practices (Table 28). If the MS4s were to adopt the Wisconsin Department of Natural Resources' methodology of leaf management (sweeping streets with >17% tree cover four times in the fall with any sweeper technology), and VTDEC continues to accept this currently-draft crediting method, the Town could achieve an additional 19.7 kg/yr P reduction (Table 29, Figure 3).

Table 28. Essex Town total P reductions from current non-structural practices

Lake Segment	Catch Basin Cleaning P Reduction (kg/yr)	Sweeping P Reduction (kg/yr)	Total P Reduction (kg/yr)	Target P Load Reduction (kg/yr)	% of Total P Reduction
Main Lake	0.20	0.85	1.05	43.60	2.4%
Malletts Bay	0.07	0.28	0.35	31.00	1.1%
Total	*0.27*	*1.13*	*1.40*	*74.60*	*1.9%*

Note: Current non-structural controls in Essex Town include sweeping routes 2 times per year (spring and fall), vacuum assisted, with a 2% maximum reduction credit, discounted 60% to account for 2004 start of present sweeping regime. Catch basin cleaning occurs once every two years, as inspections warrant.

Table 29. Essex Town potential additional P reductions from WI-based non-structural practices

Lake Segment	Additional Sweeping P Reduction (kg/yr)	Target P Load Reduction (kg/yr)	% of Total P Reduction
Main Lake	16.50	43.60	37.8%
Malletts Bay	3.23	31.00	10.4%
Total	*19.73*	*74.60*	26.4%

***Assumes sweeping routes with >17% tree cover 4 times in the fall, any technology. 17% P reduction efficiency. P reduction for current activities is subtracted. Sweeping routes EX4, EX5, EX10, EX13, and EX23 are not eligible, as tree cover is less than 17%. No change is forecast for catch basin cleaning, assumed it occurs once every two years as inspections warrant.*

Sweeping data for 2020 activity were further assessed by sweeping route to provide guidance for future enhancements if desired by Essex Town. Of the 13 routes assessed in the Clean Streets study, Town Routes 1, 3, 5, and 11, located in the Main Lake segment, were the most promising routes with tree cover <17% assessed in terms of road miles, and each with potential P credit of 2.0 kg/yr or more if the Wisconsin-style sweeping method is applied (Appendix D and Table 30). Due to pandemic related staffing challenges, the Town was not able to complete as much sweeping as anticipated, and the routes utilized in the Clean Streets study were not generally followed in 2020. Even given those challenges, the four routes discussed above tended to be swept in a way that accrued more P credit compared to other routes (Table 31). Future enhancements to sweeping frequency should be targeted to Routes 1, 3, 5, and 11 (Table 32).

Table 30.Essex Town, Road Miles and Paved Road Area by Lake Segment and Sweeping Route

	Road Miles		Paved Road Area (acres)	
Town Route	Main Lake	Malletts Bay	Main Lake	Malletts Bay
01	4.41	0.83	11.00	1.71
02	2.48		5.11	
03	3.77		7.77	
04	0.89	2.12	1.34	4.37
05	2.96	0.05	6.60	0.10
06	2.15	0.68	4.43	1.40
07		2.58		5.32
08	0.89	0.68	1.83	1.40
09	0.48	1.19	0.99	2.45
10	1.97	0.90	4.06	1.86
11	3.37		6.94	
12	2.64		5.44	
13	2.20		4.53	
Total	*27.21*	*9.01*	*57.97*	*18.56*

Table 31. Essex Town, Summary of P Reduction Credit for Sweeping by Route, 2020 data

Town Route	Main Lake P Credit (kg/yr)	Malletts Bay P Credit (kg/yr)
01	0.08	0.01
02	0.05	
03	0.06	
04	0.01	0.05
05	0.06	
06	0.04	0.02
07		0.08
08	0.02	0.02
09	0.01	0.01
10	0.04	0.02
11	0.07	
12	0.04	
13	0.04	
Total	*0.53*	*0.24*

Table 32. Essex Town, Summary of Estimated P Reduction Possible Through Application of Wisconsin Sweeping Methodology

Town Route	Main Lake (kg/yr)	Malletts Bay (kg/yr)
01	1.47	0.10
02	0.70	
03	1.06	
04		0.39
05	0.83	
06	0.60	0.19
07		0.73
08	0.25	0.17
09		0.23
10	0.27	0.11
11	0.95	
12	0.74	
13	0.62	
Total	*7.60*	*1.93*

Note: Estimated P reduction approximated assuming two lane widths of 8.5 ft. swept per street to convert road miles to acres. This results in a lower estimated P load, and thus P credit, compared to the high-level summary values provided in Table 29.

Phosphorus load reductions anticipated from implementation of the recommendations above are summarized in Table 33 for both the Village and the Town.

Table 33. P load reductions from recommended enhanced sweeping on selected routes (kg/yr)

Lake Segment	Catch Basin Cleaning P Reduction	Sweeping P Reduction	Total Non-Structural P Reduction
Village of Essex Junction Summary			
Main Lake	0.30	8.55	8.85
Malletts Bay	0.15	0.66	0.81
Total	*0.45*	*9.21*	*9.66*
Town of Essex Summary			
Main Lake	0.20	3.31	3.51
Malletts Bay	0.07	0.37	0.44
Total	*0.27*	*3.68*	*3.95*

The MS4 permit does allow sharing of implementation costs between permitted MS4s, and Section 6.3 of the permit explains the requirements for sharing implementation. During PCP development, the concept of sharing the phosphorus reduction credit accrued from potential sweeping enhancements was explored. In an example case between Essex and Essex Junction, Essex can enter into a written agreement with Essex Junction to perform enhanced street sweeping to achieve Essex Junction's total P reduction. This agreement would be included in the PCPs of both MS4s and could be reported on annually by Essex. In Essex Junction's PCP, Vermont DEC would require alternative options to achieve the P reductions in case the enhanced street sweeping or sharing agreement does not materialize. The alternative options would be planned for later years in the PCP, similar to the future growth component for FRPs. While at this time it does not appear that credit sharing will be necessary for either MS4 to meet P reduction targets, it remains an option for future consideration if and as needed.

6. Municipal Ordinances or Regulations and Future Growth

Building on a previous code review completed in 2019 by the Vermont League of Cities and Towns (VLCT), a targeted review of local ordinances and regulations was completed to evaluate:

- Compliance with Vermont MS4 General Permit requirements,
- Consistency with State stormwater management standards,
- Effectiveness in promoting green infrastructure and environmentally sensitive site design, and
- Opportunities to earn phosphorus-reduction credit.

The following Village and Town documents were reviewed:

- Town and Village Stormwater Management Ordinance (Essex Town Ordinance 10.20 and Village Code Section 1901)
- Village of Essex Junction Land Development Code
- Town of Essex Public Works Standard Specifications for Construction
- Town of Essex Subdivision Regulations
- Town of Essex Zoning Regulations

Appendix E includes the detailed results of the ordinance review and recommendations for future adjustments. Both Essex Junction and the Town of Essex anticipate beginning extensive reviews of and updates to their local land development regulations in 2021, representing a timely opportunity for the recommendations contained in Appendix E to be considered and ultimately implemented.

Appendix E also contains recommendations regarding enhancements to reporting on the inspection and maintenance of sub-jurisdictional stormwater BMPs, should the MS4s choose to include these practices as creditable in meeting MS4-required P load reductions in the PCPs in the future. In addition, if the Village or Town choose to reduce the applicability threshold for local stormwater permitting below 0.5 acres of impervious surface, the reviewers recommended establishing an offsite mitigation program or a fee-in-lieu program allowing small projects the option to pay a fee instead of constructing on-site practices. Add offsets as an option, not strictly fee based. The Village and Town may also consider adding a requirement for a property to demonstrate they have maximized treatment of stormwater on site before applicants can offset or pay fees, similar to the Engineering Feasibility Assessment (EFA) process under the Vermont DEC General Permit 3-9050.

A one-time fee may also be charged to developers turning over streets and associated drainage infrastructure to the Village or Town for management. Enabling language exists in both municipalities' ordinances to allow both of these recommendations to move forward, and refinements completed during the upcoming broader review process may enable both the Village and Town stormwater programs to generate revenue to put towards retrofits of municipally owned properties.

7. Progress Summary and Plan for Meeting Phosphorus Targets

Summarizing the P reduction benefits of structural STPs, and the benefits of present and required future MRGP improvements to road segments and outlets, demonstrates that the Essex Junction and Essex Town MS4s have both made substantial progress towards meeting the P reduction targets required under the Lake Champlain P TMDL and each MS4's general permit (Figure 4). In the Malletts Bay Lake segment, constructed and design-phase structural STPs, and other measures committed to through various regulatory requirements, exceed P reduction targets without increasing the frequency or extent of non-structural measures in both Essex Junction and Essex Town (Figure 4). Non-structural controls, and particularly enhanced street sweeping measures, represent a small proportion of the P reductions that are possible to be gained in this Lake segment, and are not necessary in order to meet target P reductions for either MS4 in the Malletts Bay drainages.

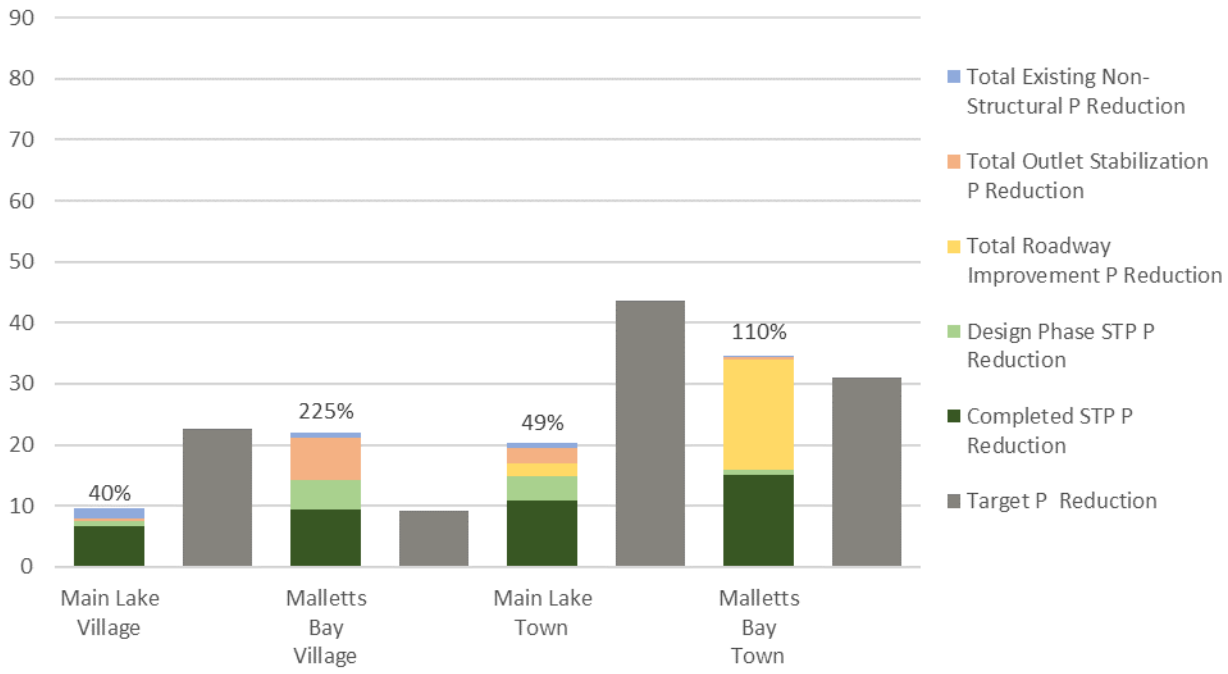


Figure 4. P load reductions (kg/yr) credited to existing and design-phase structural STPs, existing and required road segment and outlet improvements, and existing non-structural BMPs and controls, Essex Junction and Essex Town

In the Main Lake segment, constructed and design-phase BMPs, including stormwater retrofits, road segment improvements, and outfall stabilization, as well as structural measures that will be required under FRPs and the MRGP, do not meet or exceed P reduction targets without implementing additional structural STPs or increasing the frequency or extent of non-structural measures in both Essex Junction and Essex Town. The planned structural STPs identified in Sections 3.2 and 3.4, coupled with the limited enhancements to street sweeping identified in Section 5, represent one path that both MS4s may take to achieve remaining required P reductions (Figure 5 and Table 34).

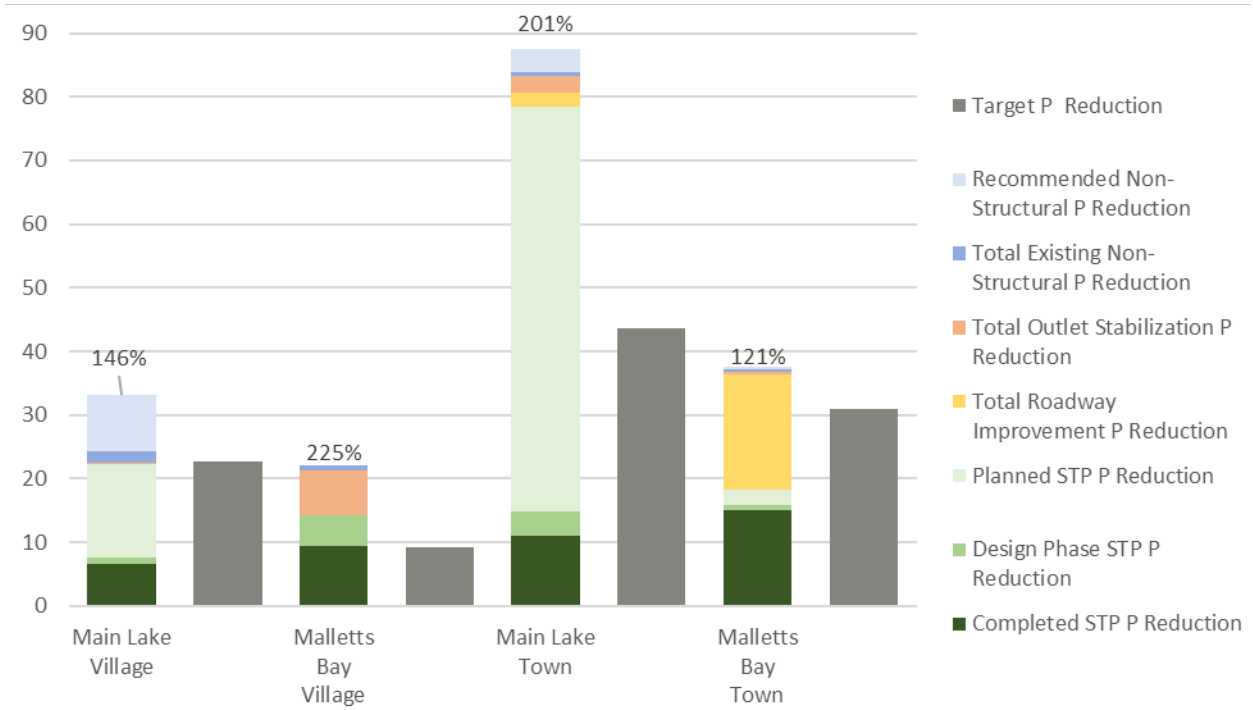


Figure 5. P load reductions (kg/yr) credited to existing, design-phase, and projected structural STPs, existing and required road segment and outlet improvements, and existing and recommended non-structural controls, Essex Junction and Essex Town

Table 34. Existing, Design-Phase, and Projected BMP P Reduction Summary

Lake Segment	Existing BMPs (kg/yr)	Design-Phase STPs and Remaining MRGP (kg/yr)	Projected BMP P Reduction (kg/yr)	Total BMP P Reduction (kg/yr)	Target P Reduction (kg/yr)	% of Total P Reduction
Village of Essex Junction Summary						
Main Lake	8.4	1.2	23.5	33.1	22.6	146%
Malletts Bay	13.5	8.5	0.0	22.1	9.1	225%
Total	*21.9*	*9.7*	*23.5*	*55.1*	*31.7*	
Town of Essex Summary						
Main Lake	13.1	7.2	67.2	87.5	43.6	201%
Malletts Bay	18.2	16.5	2.8	37.5	31.0	121%
Total	*31.3*	*23.7*	*70.0*	*125.0*	*74.6*	

Enhanced street sweeping measures may provide substantial reasonable assurance for the remaining P reductions necessary to meet target P reductions in the Main Lake segment, provided that VTDEC retains the Wisconsin-style crediting or a similar system for enhanced fall-focused street sweeping measures (Section 5 and Figure 5). However, enhanced sweeping regimes are not anticipated to be necessary in order for either Essex Junction or Essex Town to meet MS4 target P reductions.

8. Implementation Schedule

A draft implementation schedule for the Essex Junction MS4 and Essex Town MS4 PCPs is presented on the following page. This schedule will be adjusted following consultation with Vermont DEC and on an annual basis as required by Part 8.2.D of the 2018 MS4 General Permit.

This PCP represents a broad overview and remains a working document, subject to change as projects are further investigated. Projected projects, particularly structural stormwater treatment practices, require further evaluation to determine their feasibility and to refine the high-level cost estimates provided in this document. The next step is to refine the prioritization provided in the draft implementation schedule. Feasibility evaluation will be necessary, and for a few projects included in this PCP it is already underway. Projected retrofit projects with the highest cost-effectiveness and few barriers to implementation, or which are already in scoping or design phases, are likely to be advanced first. These structural stormwater retrofits include but are not limited to:

Essex Junction:

- Tyler Drive, Wilkinson Drive, and South Street

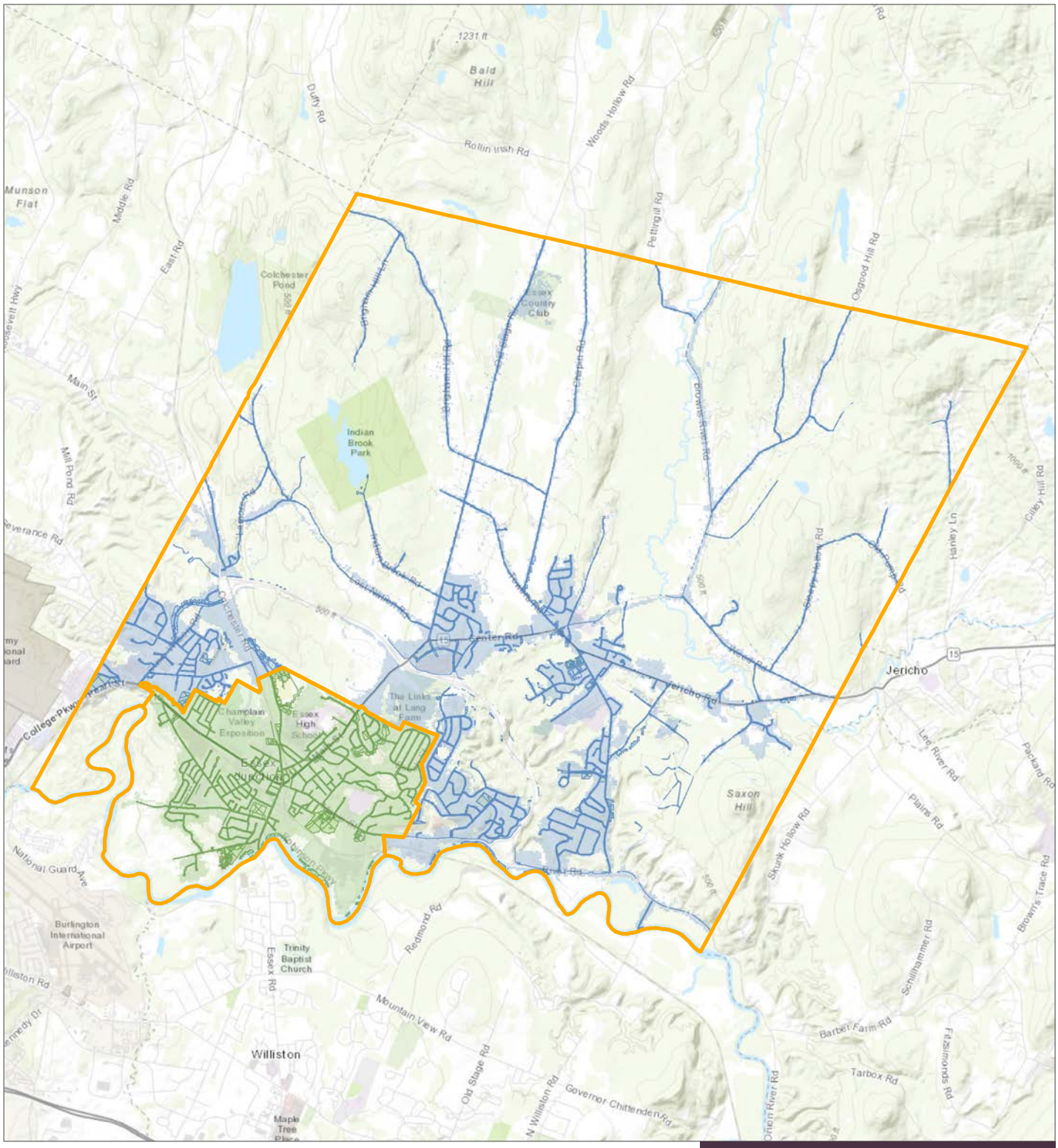
Essex Town:

- Outfall 126
- Tanglewood Drive and Fern Hollow Road
- Logwood Circle

In addition, Essex Town is beginning the preparation of a 10-year MRGP Improvement Plan, which is anticipated to be completed in 2022 and which will provide refined prioritization and customized unit-cost-based estimates for completing the remaining road segment improvements. Upon completion, the MRGP Improvement Plan will become part of this PCP pending adoption by the Town Selectboard.

Project No.	Project Description	Permit and Calendar Cycles																PCPs Complete June 17, 2036
		2018 MS4 GP			2023 MS4 GP					2028 MS4 GP					2033 MS4 GP			
		REI Update					REI Update					REI Update						
		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	
1	Sunderland Brook FRP STP Implementation	done?																
2	Indian Brook FRP STP Impementation	construct remaining designed STPs																
3	2020 Design Phase Structural STPs	complete designs		construction														
4	Essex Junction MS4 Proposed PCP Structural STPs																	
	Tyler Drive - Wilkinson Drive																	
	Loubier Drive																	
	Killoran Drive																	
	Cascadnac-Owaissa-Wenowah																	
5	Essex Town MS4 Proposed PCP Structural STPs																	
	Outfall 126																	
	Meadows Edge / Steeplebush																	
	Logwood Circle																	
	Tanglewood Dr. & Fern Hollow																	
	Saxonhollow and Hillside																	
	Sand Hill, Greenbriar, Greenfield, Wildwood																	
	Consider David Dr. Outfall for Main Lake if needed																	
6	Essex Junction Hydrologically Connected Road Segments / Outlets	complete stabilization at outlets not meeting standards								complete stabilization at outlets not meeting standards if any additional identified								
7	Essex Town Hydrologically Connected Road Segments	develop gravel RS		Implement gravel road management plan														
8	Essex Town Hydrologically Connected Outlets			complete stabilization at outlets not meeting standards						complete stabilization at outlets not meeting standards if any identified								
9	Non-Structural Controls - Enhanced Street Sweeping bot Select Main Lake Routes		develop tracking & training			implement enhanced sweeping and adjust as needed												
10	Subjurisdictional Stormwater and Future Growth	Review and adjust local ordinances					Implement and monitor lowering jurisdicitonal threshold, fee-in-lieu, transfer fees, O&M reporting as desired											

Appendix A – Maps



LEGEND

- Town and Village Boundaries
- Essex Town Phosphorus Control Plan Area
- Village of Essex Junction Phosphorus Control Plan Area
- Essex Town Developed Areas (ANR)
- Village of Essex Junction Developed Areas (ANR)

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Miles

Map 1: Phosphorus Control Plan Areas

Essex Phosphorus Control Plan

Prepared for Village of Essex Junction and Town of Essex, VT

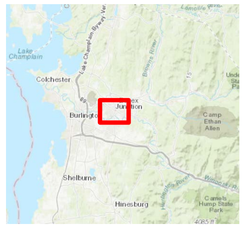
STONE ENVIRONMENTAL

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Feet



LEGEND

- MS4 Boundaries

Structural STP Locations

STP_Category
- Complete
- Design Phase
- Planned

Structural STP Drainage Areas

STP Category
- Complete
- Design Phase
- Planned

Essex Outfalls (CCRPC-UVM 2019, corrected)

Standards
- Partially Meets
- Does Not Meet

Essex Hydrogically Connected Road Segments (CCRPC-UVM 2019, corrected)

Standards
- Partially Meets
- Does Not Meet
- Surface Water (Essex Town)
- VHD Streams (VCGI)
- VHD Pond/Lake (VCGI)

Essex Junction PCP Area (Stone)
- Malletts Bay - DD
- Winooski River

Essex Town PCP Area (Stone)
- Lamoille River
- Malletts Bay - DD
- Winooski River

Lake Champlain Drainage Areas
- Winooski River
- Lamoille River
- Malletts Bay - DD

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Map 2
Essex Junction PCP Practices Structural STPs, Road Segments Not or Partially Meeting Standards, and Outlet Stabilization

Essex Phosphorus Control Plan

Prepared for Village of Essex Junction and Town of Essex, VT

STONE ENVIRONMENTAL

N

0 1,100 2,200

Feet



LEGEND

- MS4 Boundaries

Structural STP Locations

STP_Category
- Complete
- Design Phase
- Planned

Structural STP Drainage Areas

STP Category
- Complete
- Design Phase
- Projected

Essex Outfalls (CCRPC-UVM 2019, corrected)

Standards
- Partially Meets
- Does Not Meet

Essex Hydrogically Connected Road Segments (CCRPC-UVM 2019, corrected)

Standards
- Partially Meets
- Does Not Meet
- Surface Water (Essex Town)
- VHD Streams (VCGI)
- VHD Pond/Lake (VCGI)

Essex Junction PCP Area (Stone)
- Malletts Bay - DD
- Winooski River

Essex Town PCP Area (Stone)
- Lamoille River
- Malletts Bay - DD
- Winooski River

Lake Champlain Drainage Areas
- Winooski River
- Lamoille River
- Malletts Bay - DD

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Map 3
Essex Town PCP Practices
Structural STPs and Outlet Stabilization

Essex Phosphorus Control Plan

Prepared for Village of Essex Junction
and Town of Essex, VT

STONE ENVIRONMENTAL

N

0 1,600 3,200

Feet



LEGEND

- MS4 Boundaries

Essex Outfalls (CCRPC-UVM 2019, corrected)

Standards

- Does Not Meet
- Partially Meets

Essex Hydrogically Connected Road Segments (CCRPC-UVM 2019, corrected)

Standards

- Does Not Meet
- Partially Meets
- Surface Water (Essex Town)
- VHD Streams (VCGI)
- VHD Pond/Lake (VCGI)

Essex Junction PCP Area (Stone)

- Malletts Bay - DD
- Winooski River

Essex Town PCP Area (Stone)

- Lamoille River
- Malletts Bay - DD
- Winooski River

Lake Champlain Drainage Areas

- Lamoille River
- Malletts Bay - DD
- Winooski River

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Map 4
Essex Junction and Essex Town MRGP Road Segments and Outlets Not Meeting or Partially Meeting Standards

Essex Phosphorus Control Plan

Prepared for Village of Essex Junction and Town of Essex, VT

STONE ENVIRONMENTAL

Appendix B – Details for Existing, Design Phase, and Projected Structural STPs

B-1: Completed Structural STPs

B-2: FRP and Capital Projects Design-Stage Structural STPs

B-3: Operational Permit Retrofit Information – Essex Town

B-4: PCP-Identified Projected Structural STPs

B-5: Additional Projected Structural STP Retrofit Opportunities

Appendix B, Table B-1: Details for Completed Structural Stormwater Treatment Practices

ID	Site Name	Land Owner	MS4	Permit No.	Year Completed	BMP Status	Applicable FRP	LC TMDL Drainage Area	LC TMDL Lake Segment	BMP Type	Impervious area (acres)	Pervious area (acres)	Storage volume (ft^3)	P Base Load Before Treatment (kg/yr)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target Reduction
6653-9010	Village Walk POI 1	Village	Essex Junction MS4	6653-9010	2015	Complete	n/a	Winooski River	Main Lake	Infiltration Basin	3.32	6.22	26,586	5.15	99.2%	5.11	23%
6653-9010	Village Walk POI 2	Village	Essex Junction MS4	6653-9010	2015	Complete	n/a	Winooski River	Main Lake	Infiltration Basin	0.63	1.23	12,803	0.99	100.0%	0.99	4%
6653-9010	Village Walk POI 3	Village	Essex Junction MS4	6653-9010	2015	Complete	n/a	Winooski River	Main Lake	Infiltration Basin	0.32	0.96	6,849	0.58	100.0%	0.58	3%
6006-9020.1	Taft Street S/N 001	Village	Essex Junction MS4	6006-9020.1	2016	Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	0.48	1.02	3,528	0.41	54.9%	0.22	2%
6006-9020.1	Taft Street S/N 002	Village	Essex Junction MS4	6006-9020.1	2016	Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	0.54	0.96	2,090	0.46	47.4%	0.22	2%
1 1074 SN 002	Fairview Drive/Main St Gravel Wetland	Village	Essex Junction MS4	1 1074 SN 002	2019	Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Gravel Wetland	3.75	18.77	40,800	3.32	62.2%	2.06	23%
2-0317/2-0952	Mansfield Brickyard Gravel Wetland	Private	Essex Junction MS4	2-0317/2-0952	2020	Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Gravel Wetland	11.39	6.28	70,153	9.47	65.3%	6.08	67%
4989 INDO	5 Corners North	Essex School D	Essex Junction MS4	4989 INDO		Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Underground Detention	13.89	17.00	11,892	11.66	8.0%	0.72	8%
3081-9010.R	Perkins Bend 002	Town	Essex Town MS4	3081-9010.R	2010	Complete	n/a	Winooski River	Main Lake	Infiltration Chambers	6.00	7.30	1,520	8.39	22.4%	1.88	4%
7025.9014.ARA	Essex Police Station	Town	Essex Town MS4	7025.9014.ARA	2014	Complete	n/a	Winooski River	Main Lake	Bioretention (w/ underdrain)	1.14	2.50	3,554	1.85	44.4%	0.82	2%
7025.9014.ARA	Essex Police Station	Town	Essex Town MS4	7025.9014.ARA	2014	Complete	n/a	Winooski River	Main Lake	Grass Channel	1.14	2.50	978	1.85	5.2%	0.10	0.2%
Outfall 199	Outfall 199 Morse Dr.	Town	Essex Town MS4	NP		Complete	Sunderland Brook	Winooski River	Main Lake	Infiltration Trench	5.18	3.00	5,009	6.48	80.2%	5.20	12%
5944-INDO.R	Kellogg Rd Detention Pond	Town	Essex Town MS4	5944-INDO.R	2011	Complete	Sunderland Brook	Winooski River	Main Lake	Wet pond/ Created Wetland	9.50	14.00	170,450	11.54	63.0%	7.27	17%
5263-9015	Tanglewood Drive infiltration (Birchwood Manor) - anticipated MS4 transfer in 2021-2022	Town	Essex Town MS4	5263-9015	2012	Complete	n/a	Winooski River	M	Bioretention (infiltrating)	1.81	1.00	6,423	2.04	97.8%	2.00	5%
4181-9015.3	Thompson Drive infiltration - anticipated MS4 transfer in 2021	Town	Essex Town MS4	4181-9015.3	2014	Complete	n/a	Winooski River	Main Lake	Infiltration Trench	0.80	0.20	2,795	0.90	99.8%	0.90	2%
1 1186	Sydney Drive - Woodlands II Lang Farm Parcel	Town	Essex Town MS4	1-1186	2020	Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Infiltration Chambers	4.04	28.76	38,812	3.68	92.2%	3.39	11%
4002_INDS.A	Essex Town Center Essex Outlets	Private	Essex Town MS4	4002 INDS.A		Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	6.45	6.08	28,009	1.00	51.9%	0.39	1%
6262_9020	Essex Outlets Pond A	Private	Essex Town MS4	6262 9020		Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	5.65	9.07	74,139	4.77	62.4%	2.98	10%
6262_9020	Essex Outlets Pond B	Private	Essex Town MS4	6262 9020		Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	3.77	1.22	40,772	3.12	0.63	1.97	6%
6262 9020	Essex Outlets Pond C	Private	Essex Town MS4	6262 9020		Complete	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Wet pond/ Created Wetland	11.85	10.30	290,966	9.90	63.0%	6.24	20%

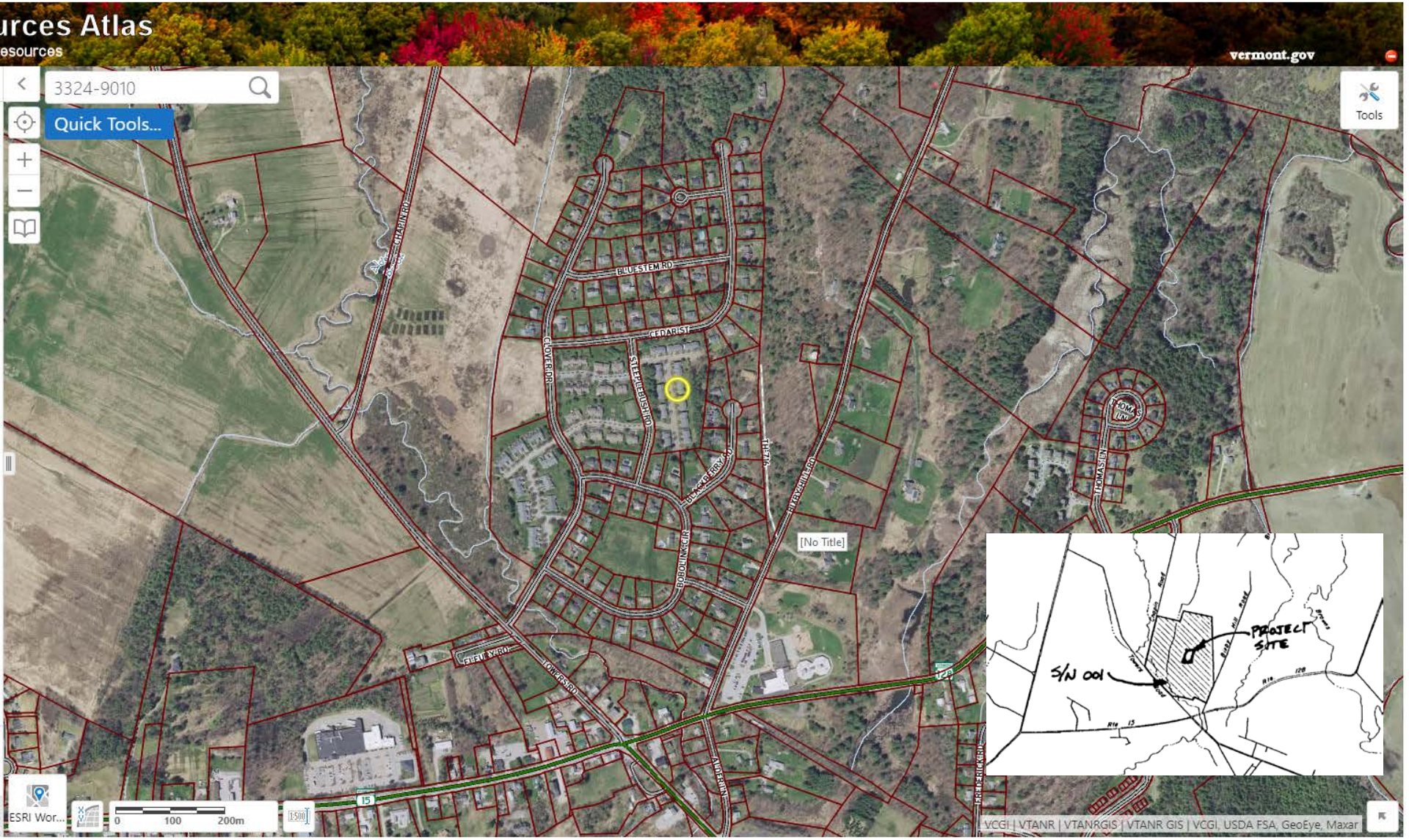
Note: n/a = not applicable

Appendix B, Table B-2: Details for Design-Phase Structural Stormwater Treatment Practices

ID	Site Name	Land Owner	MS4	Permit No.	Year Planned Construction	BMP Status	Applicable FRP	LC TMDL Drainage Area	LC TMDL Lake Segment	BMP Type	Impervious area (acres)	Pervious area (acres)	Storage volume (ft^3)	P Base Load Before Treatment (kg/yr)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target Reduction
TAP TA 18(2) Acorn 3	Acorn Circle cul-de-sac retrofit - media filter with specialized media	Village	Essex Junction MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Sand filter (w/ underdrain)	1.10	0.70	3,700	1.39	48.2%	0.87	4%
TAP TA 18(2) Acorn 3	Acorn Circle cul-de-sac retrofit - impervious removal	Village	Essex Junction MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Impervious removal	1.04			1.36		0.03	0.1%
2 0155	Countryside Dr Intersection	ROW	Essex Junction MS4	2_0155		Preliminary Design (<100%)	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Infiltration Chambers	1.95	3.30	4,792	1.65	68.0%	1.12	12%
2 0187	Grove St.	ROW	Essex Junction MS4 and VTrans	2 0187		Preliminary Design (<100%)	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Infiltration Chambers	8.71	14.68	2,047	7.37	31.2%	2.30	25%
TAP TA 18(2) Oakwood 1	Oakwood Drive cul-de-sac retrofit - media filter with specialized media	Town	Essex Town MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Sand filter (w/ underdrain)	2.13	3.68	11,500	3.43	54.5%	2.71	6%
TAP TA 18(2) Oakwood 1	Oakwood Drive cul-de-sac retrofit - impervious removal	Town	Essex Town MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Impervious removal	2.03			3.29		0.14	0.32%
TAP TA 18(2) Sage 1	Sage Circle cul-de-sac retrofit - infiltration trenches	Town	Essex Town MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Infiltration Trench	0.80	1.30	6,096	0.92	100.0%	0.92	2.12%
TAP TA 18(2) Sage 1	Sage Circle cul-de-sac retrofit - impervious removal	Town	Essex Town MS4		2021	Preliminary Design (<100%)	n/a	Winooski River	Main Lake	Impervious removal	0.74			0.85		0.06	0.14%
Outfall 126	Outfall 126: Fort Ethan Allen (Ryan St.)	Town	Essex Town MS4		2027?	Preliminary Design (<100%)	Sunderland Brook	Winooski River	Main Lake	Infiltration Basin	9.84	10.58	41,600	13.44	97.6%	13.11	30.06%
Outfall 199	Outfall 199 Morse Dr.	Town	Essex Town MS4			Preliminary Design (<100%)	Sunderland Brook	Winooski River	Main Lake	Infiltration Trench	5.18	3.00	5,009	6.48	80.2%	5.20	11.92%
1_0896, 1_0552, 1_1463	David Dr. Outfall	ROW	Essex Town MS4	1_0896, 1 0552, 1_1463	2032?	Preliminary Design (<100%)	Sunderland Brook	Winooski River	Main Lake	Infiltration Chambers	15.96	16.25	61,028	21.58	96.5%	20.82	48%
1_1319_p1_South	Church of Jesus Christ of Latter Day Saints, South Vault	Private	Essex Town MS4	1 1319	2022	Final Design (100%)	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Sand filter (w/ underdrain)	1.83	0.67	13,286	1.52	60.0%	0.91	3%
1 1319_p2_North	Church of Justice Christ of Latter Day Saints, North Vault	Private	Essex Town MS4	1 1319	2022	Final Design (100%)	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Detention Chambers (negligible P treatment)	---	---	---	---	---	---	0%

Note: n/a = not applicable

Meadows Edge/ Steeplebush 3324-9010.R



Meadows Edge/ Steeplebush 3324-9010.R




CEDAR COURT
BLUESTEM ROAD
CEDAR STREET
Steeplebush East
Steeplebush West
PRIVATE
PRIVATE
PRIVATE
UNDEFINED OWNERSHIP
UNDEFINED OWNERSHIP
LAGOON NOT OWNED BY TOWN
The Commons at Meadows Edge
TOWERS ROAD
=KEY=
— PRIVATE SYSTEM OR UNKNOWN OWNERSHIP
IMPERVIOUS AREA NOT INCLUDED IN TOWN PERMIT COVERAGE UNDER 3-9010
NO FEES PAID FOR THESE AREAS BY TOWN
AREAS HAVE ASSOCIATIONS



Meadows Edge/
Steeplebush 3324-9010.R
6+ acre impervious
Grass channels
Detention pond





Autumn Knoll 4367-9010.R (~2002)

S/N 001

Existing dry ED = 0.39 kg/yr

Existing wet ED = 1.88 kg/yr



Autumn Knoll 4367-9010.R (~2002)

S/N 001

Existing dry ED = 0.39 kg/yr

Existing wet ED = 1.88 kg/yr



Autumn Knoll 4367-9010.R

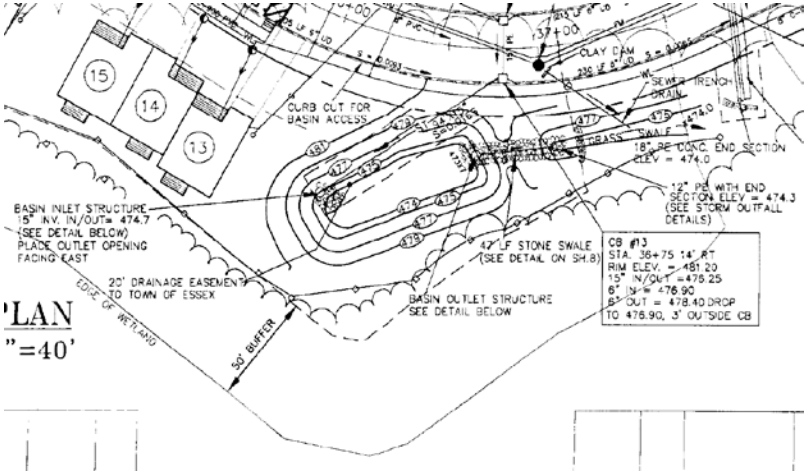
S/N 001(~2002)

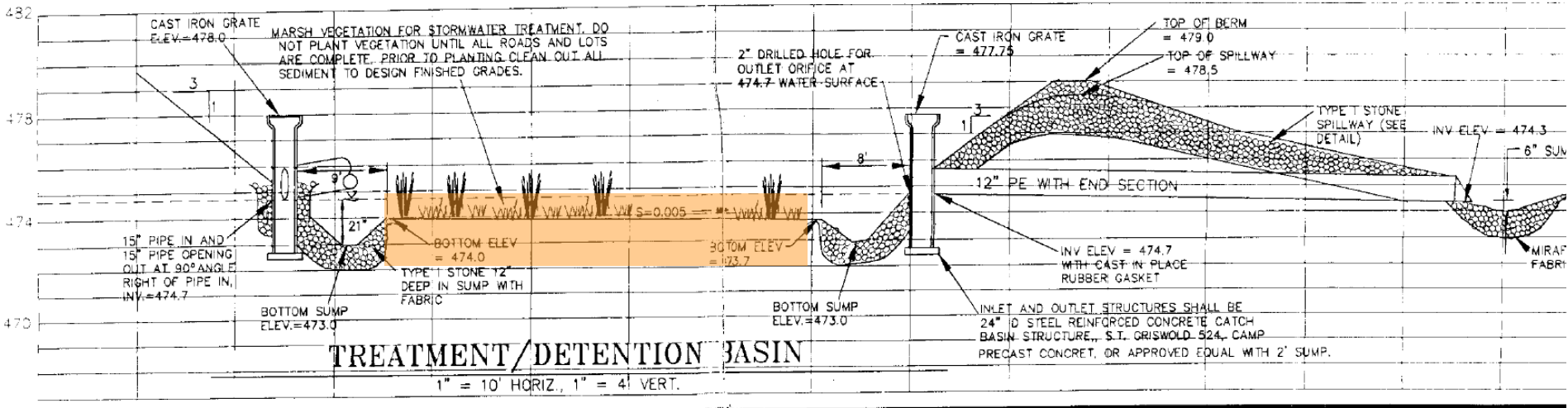
Existing Wet ED = 1.88 kg/yr

Expand / Convert to gravel wetlands = 1.15 kg/yr

Total = 3.03 kg/yr +







Old Stage Village 3579-9010.R

4.12 ac impervious

Grass channels



Old Stage Village 3579-9010.R

4.12 ac impervious

Grass channels



Appendix B, Table B-4: Details for PCP Projected Stormwater Treatment Practices

ID	Site Name	Land Owner	MS4	Permit No.	Year Planned	BMP Status	FRP	LC TMDL Drainage Area	LC TMDL Lake Segment	BMP Type	Impervious area (acres)	Pervious area (acres)	Storage volume (ft^3)	P Base Load Before Treatment (kg/yr)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target Reduction	Estimated Implementation Cost ($2021)	$/CF managed	$/acre impervious managed	$/kg P/yr managed
EJ-WR-022	CB90 Loubier Drive drywell	Village	Essex Junction MS4		2027	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.81	0.88	2,953	0.92	99.9%	0.92	4.1%	$59,100	$20	$72,963	$64,157
EJ-WR-023	CB91 Loubier Drive drywell	Village	Essex Junction MS4		2027	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.43	0.72	1,614	0.49	99.9%	0.49	2.2%	$32,300	$20	$75,116	$65,337
EJ-WR-024	CB92 Loubier Drive drywell	Village	Essex Junction MS4		2027	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.43	0.89	1,644	0.50	100.0%	0.50	2.2%	$32,900	$20	$76,512	$66,071
EJ-WR-025	CB757 Loubier Drive drywell	Village	Essex Junction MS4		2027	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.21	0.75	860	0.25	100.0%	0.25	1.1%	$17,300	$20	$82,381	$69,319
EJ-WR-026	Loubier Drive cul de sacs impervious removal	Village	Essex Junction MS4		2027	Planned	n/a	Winooski River	Main Lake	Impervious removal	0.19	0.00	n/a	0.22	97.2%	0.21	0.9%	$10,000	n/a	$52,632	$47,619
EJ-WR-027	CB54 and CB55 Killoran Drive drywells	Village	Essex Junction MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.31	0.44	1,194	0.36	100.0%	0.36	1.6%	$23,900	$20	$77,097	$67,311
EJ-WR-028	CB56 and CB57 Killoran Drive drywells	Village	Essex Junction MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.91	0.96	3,154	1.04	99.6%	1.03	4.6%	$63,100	$20	$69,341	$61,144
EJ-WR-029	CB1425 Killoran Drive drywell	Village	Essex Junction MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.41	0.32	1,472	0.46	99.8%	0.46	2.1%	$29,500	$20	$71,951	$63,630
EJ-WR-030	Killoran Drive cul de sac impervious removal	Village	Essex Junction MS4		2029	Planned	n/a	Winooski River	Main Lake	Impervious removal	0.05	0.00	n/a	0.06	100.0%	0.06	0.3%	$2,500	n/a	$50,000	$41,667
EJ-WR-031	CB35 Cascadnac Ave drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.43	0.17	1,586	0.48	100.0%	0.48	2.1%	$31,800	$20	$73,953	$65,742
EJ-WR-032	CB36 Cascadnac Ave drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.14	0.17	639	0.16	100.0%	0.16	0.7%	$12,800	$20	$91,429	$80,110
EJ-WR-033	CB37 Cascadnac Ave drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.11	0.20	541	0.13	99.0%	0.13	0.6%	$10,900	$20	$99,091	$86,740
EJ-WR-034	CB42 Cascadnac and Owaissa Ave drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.19	0.19	802	0.22	98.5%	0.21	0.9%	$16,100	$20	$84,737	$75,664
EJ-WR-035	CB43 Owaissa and Wenonah drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.23	0.16	933	0.26	98.4%	0.26	1.1%	$18,700	$20	$81,304	$73,085
EJ-WR-036	CB44 Wenonah Ave drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.19	0.21	802	0.22	98.5%	0.21	0.9%	$16,100	$20	$84,737	$75,536
EJ-WR-037	CB706 Wenonah & Owaissa drywell	Village	Essex Junction MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.13	0.10	606	0.15	99.0%	0.15	0.6%	$12,200	$20	$93,846	$83,724
EJ-WR-038	Tyler Drive, Wilkinson Drive - South St. intersection - retrofit/expand	Village	Essex Junction MS4		2025	Planned	n/a	Winooski River	Main Lake	Infiltration Basin	7.86	5.46	28,096	8.89	99.8%	8.87	39.3%	$168,600	$6	$21,450	$19,000
Outfall 126	Outfall 126: Fort Ethan Allen (Ryan St.)	Town	Essex Town MS4		2027?	Planned	Sunderla	Winooski River	Main Lake	Infiltration Basin	9.84	10.58	41,600	13.44	97.6%	13.11	30.06%	$415,300	$10	$42,205	$31,683
1_0896, 1 0552, 1_1463	David Dr. Outfall	ROW	Essex Town MS4	1_0896, 1 0552, 1_1463	2032?	Planned	Sunderla	Winooski River	Main Lake	Infiltration Chambers	15.96	16.25	61,028	21.58	96.5%	20.82	48%	$852,200	$14	$53,396	$40,931
EX-LR-001	Autumn Knoll S/N 001 RETROFIT	Town	Essex Town MS4	4367-9010.F	2034?	Planned	n/a	Lamoille River	Malletts Bay	Gravel Wetland	3.03	3.91	10,081	4.34	54.7%	2.38	7.7%	$171,400	$17	$56,568	$72,142
EX-WR-001	Meadows Edge/Steeplebush RETROFIT	Town	Essex Town MS4	3324-9010.F	2027	Planned	n/a	Winooski River	Main Lake	Gravel Wetland	6.59	61.50	21,711	21.57	42.2%	9.10	21%	$369,100	$17	$56,009	$40,549
EX-WR-002	CB772-775 Foster Rd drywells	Town	Essex Town MS4		2034	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.34	2.42	4,559	1.55	99.5%	1.54	4%	$91,200	$20	$68,060	$59,329
EX-WR-003	CB884 CB885 Saxonhollow drywells	Town	Essex Town MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.65	1.57	2,305	0.76	99.6%	0.76	2%	$46,200	$20	$71,077	$61,039
EX-WR-004	CB889 CB890 CB891 Saxonhollow and Hillside drywells	Town	Essex Town MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.77	1.66	2,697	0.89	99.6%	0.89	2%	$54,000	$20	$70,130	$60,712
EX-WR-005	CB892 893 894 895 Saxonhollow Hillside drywells	Town	Essex Town MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.71	1.00	2,501	0.81	99.7%	0.81	2%	$50,100	$20	$70,563	$61,819
EX-WR-006	CB897 898 Hillside Ave drywells	Town	Essex Town MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.44	0.78	1,619	0.51	99.8%	0.51	1%	$32,400	$20	$73,636	$64,005
EX-WR-007	CB898 899 Hillside Ave drywells	Town	Essex Town MS4		2029	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.29	0.74	1,129	0.34	98.0%	0.33	1%	$22,600	$20	$77,931	$68,098
EX-WR-008	CB1046-1050 Sand Hill Rd drywells	Town	Essex Town MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.87	2.49	3,024	1.02	99.5%	1.02	2%	$60,500	$20	$69,540	$59,539
EX-WR-009	CB957-960 Greenbriar Dr drywells	Town	Essex Town MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.77	1.22	2,697	0.88	99.6%	0.88	2%	$54,400	$20	$70,649	$61,732
EX-WR-010	CB964 968-970 Greenfield Rd drywells	Town	Essex Town MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.09	2.53	3,743	1.86	93.5%	1.74	4%	$74,900	$20	$68,716	$43,050
EX-WR-011	CB1120 1121 Wildwood Dr drywells	Town	Essex Town MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.24	0.54	949	0.38	96.1%	0.36	1%	$19,000	$20	$80,851	$52,545
EX-WR-012	CB1122 1123 Wildwood Dr drywells	Town	Essex Town MS4		2032	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.23	0.36	933	0.35	96.3%	0.34	1%	$18,700	$20	$81,304	$55,765
EX-WR-041	2OLET120 Logwood Circle stormline and catchbasin retrofits	Town	Essex Town MS4		2028	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.33	3.90	5,294	1.56	98.0%	1.53	4%	$105,900	$20	$79,624	$69,086
EX-WR-039	2OLET88 Tanglewood Drive and Fern Hollow Road retrofits (Alternative 4)	Town	Essex Town MS4		2026	Planned	n/a	Winooski River	Main Lake	Dry Swale (w/ underdrain)	6.66	11.50	18,774	10.10	44.0%	4.44	10%	$410,000	$22	$61,565	$92,302
EX-WR-040	2OLET56 Craftsbury Court pond retrofit	Town	Essex Town MS4	3581-9010.F	2034?	Planned	n/a	Winooski River	Main Lake	Gravel Wetland	2.55	7.31	20,100	5.51	63.0%	2.81	6%	$341,700	$17	$134,000	$121,678
EX-WR-042	2OLET120 Logwood Circle stormline retrofit and infiltration chambers	Town	Essex Town MS4		2028	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.02	3.80	4,078	1.38	97.9%	1.35	3%	$81,600	$20	$80,000	$60,355
EX-WR-043	2OLET120 Logwood Circle stormline and catchbasin retrofits	Town	Essex Town MS4		2028	Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.18	2.65	4,550	1.37	98.0%	1.34	3%	$91,100	$20	$77,203	$67,825

Note: n/a = not applicable

Appendix B, Table B-5: Details for Projected Stormwater Treatment Practices Not Advanced in PCP

ID	Site Name	Land Owner	MS4	Permit No.	BMP Status	FRP	LC TMDL Drainage Area	LC TMDL Lake Segment	BMP Type	Impervious area (acres)	Pervious area (acres)	Storage volume (ft^3)	P Base Load Before Treatment (kg/yr)	Practice Efficiency (%)	P Credit (kg/yr)	% of P Target Reduction	Estimated Implementation Cost ($2021)	$/CF managed	$/acre impervious managed	$/kg P/yr managed
EJ-MB-001	Briar Lane cul-de-sac impervious removal	Village	Essex Junction MS4		Planned	Indian Brook	Malletts Bay Direct Drainage	Malletts Bay	Impervious removal	0.17	0.00	n/a	0.14	98.5%	0.14	1.5%	$2,500	n/a	$14,706	$17,857
EJ-WR-001	Maplewood Lane cul-de-sac	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Sand filter (w/ underdra	0.60	1.12	2,142	1.01	49.4%	0.50	2.2%	$49,300	$23	$82,167	$98,883
EJ-WR-019	CB522 Elm St drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.16	0.39	623	0.19	98.0%	0.18	0.8%	$12,500	$20	$78,125	$68,385
EJ-WR-018	CB521 Elm St drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.32	0.31	1,160	0.36	97.7%	0.36	1.6%	$23,200	$20	$72,500	$65,290
EJ-WR-020	CB523 Elm and Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	1.33	0.23	4,628	1.49	99.8%	1.49	6.6%	$92,600	n/a	$69,624	$62,282
EJ-WR-017	CB525 Elm and Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.18	0.30	675	0.21	97.9%	0.20	0.9%	$13,600	$20	$75,556	$67,119
EJ-WR-015	CB533 Jackson and McGregor drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.68	0.64	2,461	0.77	97.7%	0.75	3.3%	$49,300	$20	$72,500	$65,325
EJ-WR-014	CB546 McGregor and Grant drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.33	0.26	1,185	0.37	97.7%	0.37	1.6%	$23,800	$20	$72,121	$65,182
EJ-WR-013	CB532 MCGregor and Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.14	0.13	506	0.16	97.7%	0.16	0.7%	$10,200	n/a	$72,857	$65,663
EJ-WR-011	CB535 Grant and Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.15	0.21	555	0.17	97.8%	0.17	0.7%	$11,200	$20	$74,667	$66,674
EJ-WR-009	CB536 Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.25	0.77	1,002	0.29	98.0%	0.29	1.3%	$20,100	$20	$80,400	$69,578
EJ-WR-012	CB531 Jackson and Wrisley drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.15	0.21	555	0.17	97.8%	0.17	0.7%	$11,200	$20	$74,667	$66,674
EJ-WR-010	CB537 Jackson and Grant drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.23	0.27	842	0.26	97.8%	0.26	1.1%	$16,900	$20	$73,478	$65,904
EJ-WR-007	CB544 Camp drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.09	0.16	339	0.10	97.9%	0.10	0.4%	$6,800	$20	$75,556	$66,975
EJ-WR-006	CB543 Camp drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.05	0.20	209	0.06	98.1%	0.06	0.3%	$4,200	$20	$84,000	$71,535
EJ-WR-004	CB541 Camp drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.26	0.16	926	0.29	97.6%	0.29	1.3%	$18,600	$20	$71,538	$64,877
EJ-WR-005	CB542 Camp drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.20	0.10	708	0.23	97.6%	0.22	1.0%	$14,200	$20	$71,000	$64,538
EJ-WR-008	CB538 Camp and Jackson drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.19	0.42	731	0.22	98.0%	0.22	1.0%	$14,700	$20	$77,368	$68,015
EJ-WR-002	CB754 and CB755 Oak St drywells	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.23	0.24	837	0.26	99.9%	0.26	1.2%	$16,800	$20	$73,043	$64,279
EJ-WR-003	CB756 Oak St drywell	Village	Essex Junction MS4		Planned	n/a	Winooski River	Main Lake	Infiltration Trench	0.23	0.24	837	0.26	99.9%	0.26	1.2%	$16,800	$20	$73,043	$64,279
Outfall 199	Outfall 199 Morse Dr.	Town	Essex Town MS4		Planned	Sunderla	Winooski River	Main Lake	Infiltration Trench	5.18	3.00	5,009	6.48	80.2%	5.20	11.92%	$38,600	$8	$7,452	$7,425
3579-9010.R	Old Stage Village S/N 001 RETROFIT	Town	Essex Town MS4	3579-9010.R	Planned	n/a	Winooski River	Main Lake	Dry Swale (w/ underdrain)	4.18	33.60	13,838	12.43	38.7%	4.81	11%	$263,000	$19	$62,919	$54,678
3081-9010.R	Perkins Bend 002 impervious removal	Town	Essex Town MS4	3081-9010.R	Planned	n/a	Winooski River	Main Lake	Impervious removal	0.30	0.00	n/a	0.31	96.8%	0.30	1%	$2,500	n/a	$8,333	$8,333

Note: n/a = not applicable

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EJ-WR-022, EJ-WR-023,EJ-WR-024, EJ-WR-025, EJ-WR-026		
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Loubier Drive		
Number of STPs:	5		
STP Types:	Infiltration Trench, Impervious Removal		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff. Retrofit cul-de-sac to reduce existing impervious cover.

Feasibility constraints:

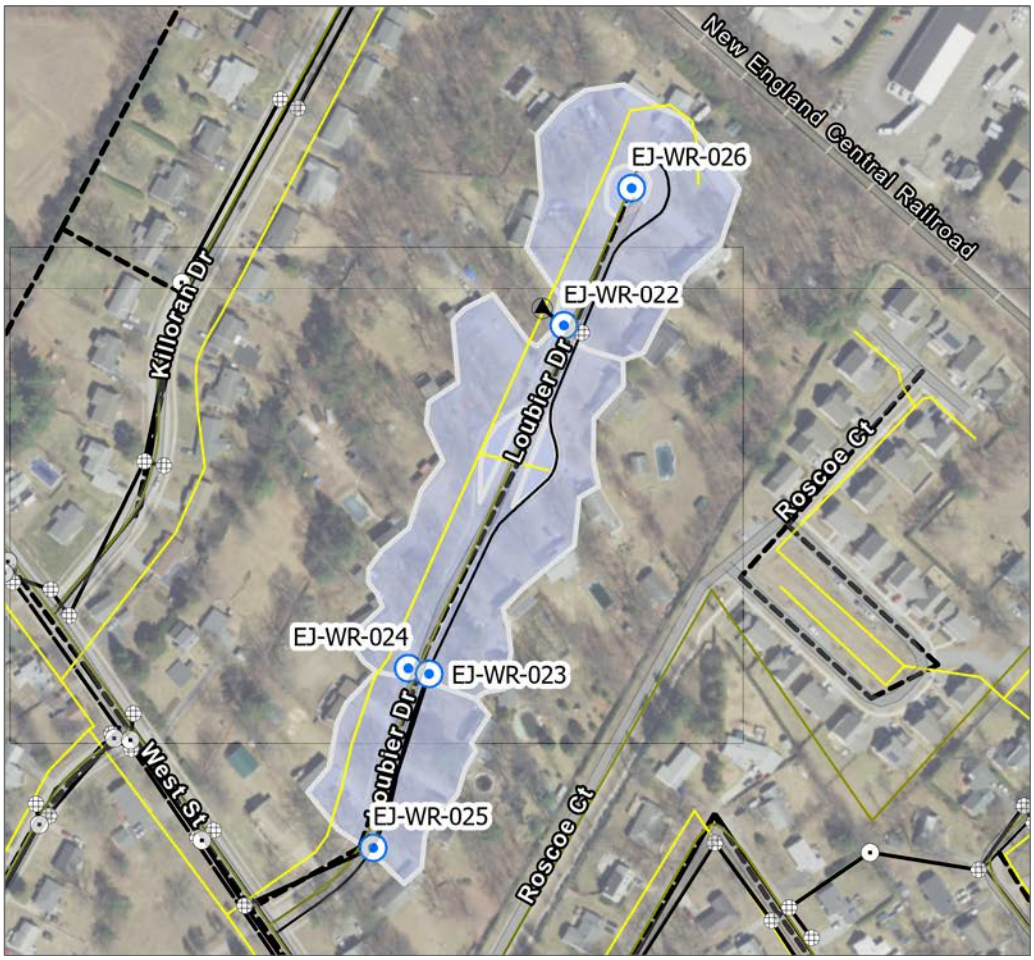
Utility Conflicts: Cable, Sewer, Water lines
Comments:
Two cul-de-sacs exist along this street, the road was extended through the southern one.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$161,600.00
Total Drainage Area (acres)	5.5
Impervious area managed (acres)	2.07
Pervious area managed (acres)	3.43
Percent Impervious (%)	37.64%
Base P Load (kg/yr)	2.38
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	7,071.24
Practice Efficiency (%)	99.4%
P Credit (kg/yr)	2.37
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	78,100
$ per kg of P managed	68,100

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Feet

N

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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs:	EJ-WR-027, EJ-WR-028, EJ-WR-029, EJ-WR-030	
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Killoran Drive		
Number of STPs:	4		
STP Types:	Infiltration Trench, Impervious Removal		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff. Retrofit cul-de-sac to reduce existing impervious cover.

Feasibility constraints:

Utility Conflicts: Cable, Sewer, Water lines
Comments:

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$121,500.00
Total Drainage Area (acres)	3.4
Impervious area managed (acres)	1.68
Pervious area managed (acres)	1.72
Percent Impervious (%)	49.41%
Base P Load (kg/yr)	1.91
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	5,820.7
Practice Efficiency (%)	99.87%
P Credit (kg/yr)	1.91
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	72,300
$ per kg of P managed	63,600

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EJ-WR-031, EJ-WR-032, EJ-WR-033, EJ-WR-034, EJ-WR-035, EJ-WR-036, EJ-WR-037		
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Cascadnac-Owaissa		
Number of STPs:	7		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Gas, Cable, Sewer, Water lines

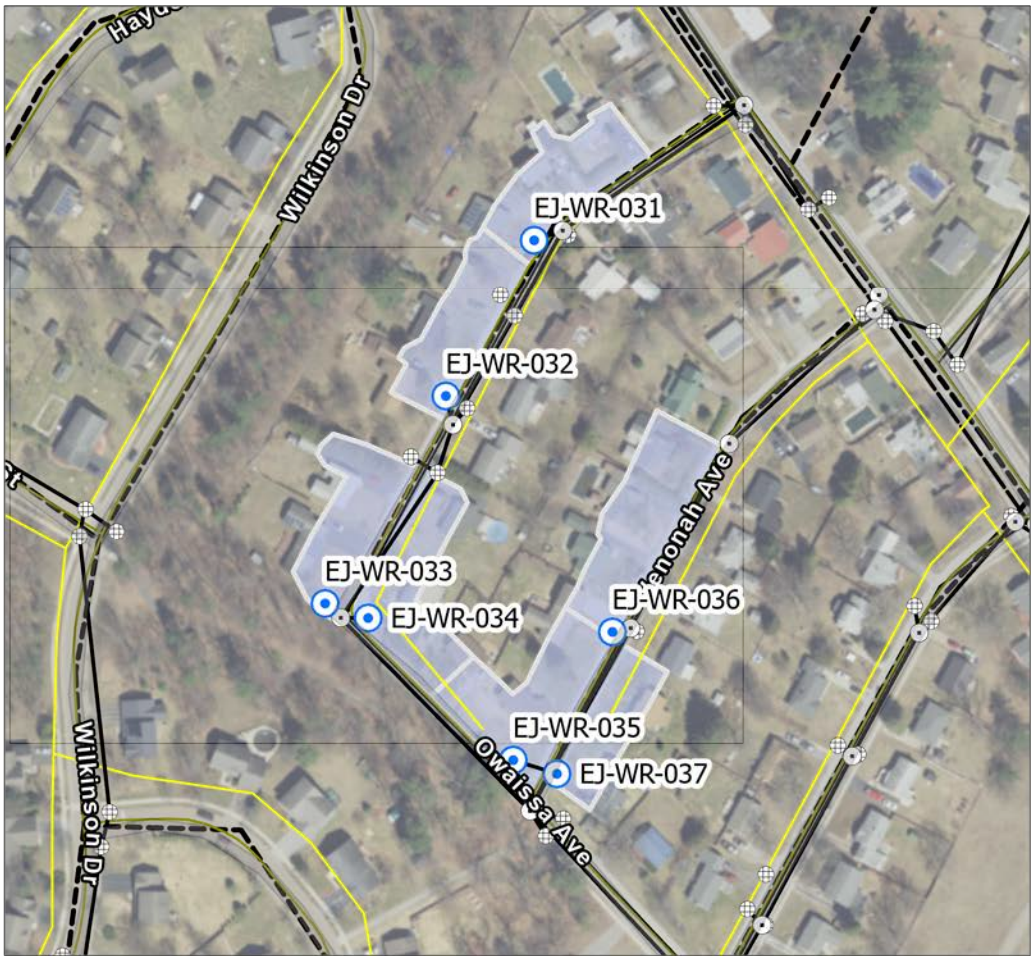
Comments:
Opportunity to apply a distributed, "invisible green infrastructure" approach at the neighborhood scale.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$118,600.00
Total Drainage Area (acres)	2.62
Impervious area managed (acres)	1.42
Pervious area managed (acres)	1.2
Percent Impervious (%)	54.2%
Base P Load (kg/yr)	1.61
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	5,909.64
Practice Efficiency (%)	99.06%
P Credit (kg/yr)	1.6
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	83,500
$ per kg of P managed	74,300

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Feet

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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	EJ-WR-038
Drainage Area:	Winooski River	**Responsible Party:**	Essex Junction MS4
Project Name:	Tyler Drive, Wilkinson Drive - South St. intersection		
STP Latitude and Longitude:	44.487579, -73.132118		
STP Type:	Infiltration Trench		

STP description:

Retrofit existing grass channel with outlet structure to increase storage volume and infiltration capacity.

Feasibility constraints and comments:

Utility Conflicts:

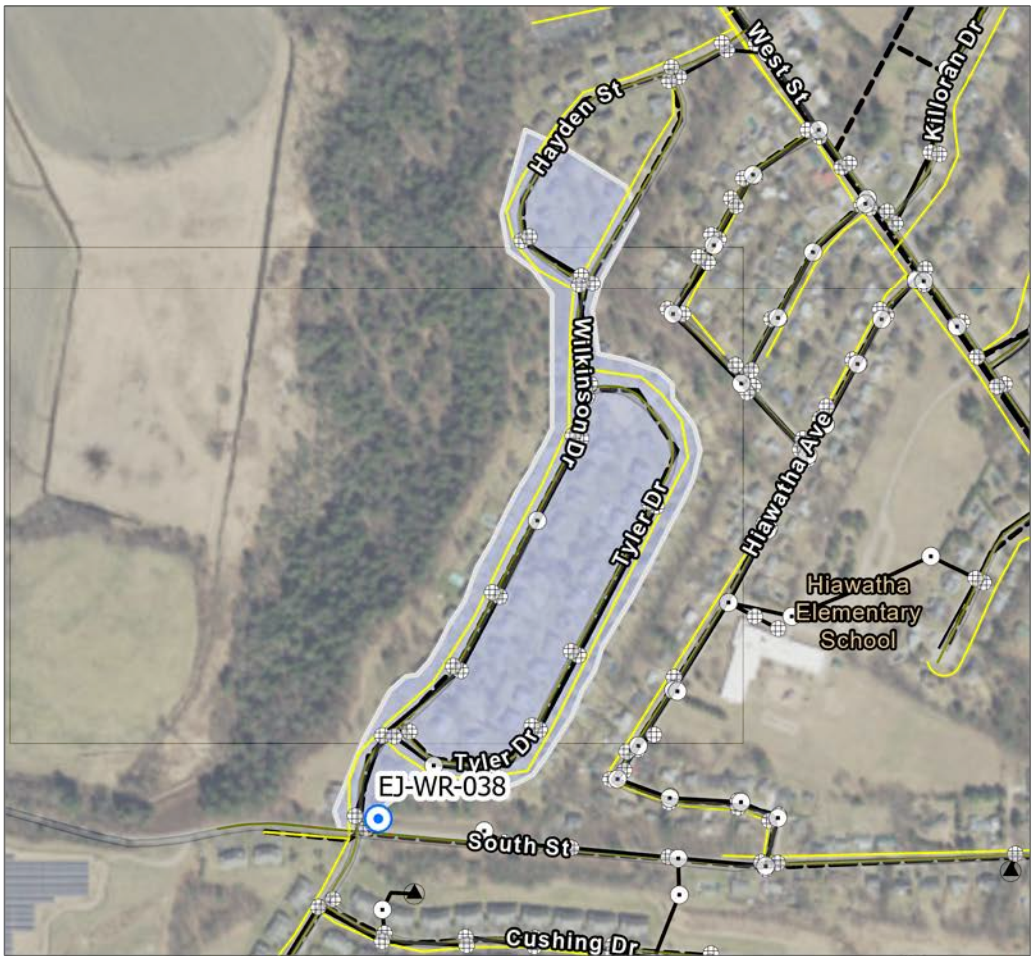
Comments:
High-priority retrofit - limited utility constraints and straightforward construction / maintenance access.

Additional Project Benefits:
Adjacent to multi-use path, educational/demonstration opportunity.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$168,600.00
Total Drainage Area (acres)	13.32
Impervious area managed (acres)	7.86
Pervious area managed (acres)	5.46
Percent Impervious (%)	59.01%
Base P Load (kg/yr)	8.89
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	28,096.2
Practice Efficiency (%)	99.83%
P Credit (kg/yr)	8.87
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	21,500
$ per kg of P managed	19,000

Site map

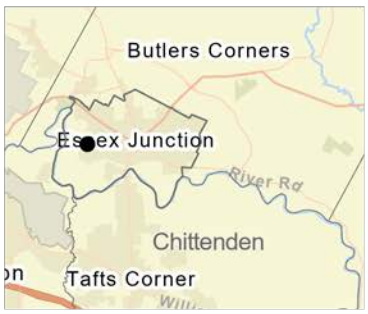


LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Feet

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STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Malletts Bay	Unique STP ID:	EX-LR-001
Drainage Area:	Lamoille River	Responsible Party:	Essex Town MS4
Project Name:	Autumn Knoll S/N 001 RETROFIT		
STP Latitude and Longitude:	44.510208, -73.049698		
STP Type:	Gravel Wetland		

STP description:

Convert existing wet pond at Autumn Knoll (4367-9010.R) into a gravel wetland and maintain existing pond's extended detention

Feasibility constraints and comments:

Utility Conflicts: Cable, Sewer, Water lines

Comments:
Practice conversion improves P reduction efficiency but less cost-effective than infiltration-based retrofits elsewhere.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$171,400.00
Total Drainage Area (acres)	6.94
Impervious area managed (acres)	3.03
Pervious area managed (acres)	3.91
Percent Impervious (%)	43.66%
Base P Load (kg/yr)	4.34
Hydrologic Soil Group (HSG)	Unknown
Water Quality volume managed (cubic feet)	10,080.51
Practice Efficiency (%)	54.75%
P Credit (kg/yr)	0.47
Infiltration Rate (inches/hr)	n/a
$ per acre of impervious managed	56,600
$ per kg of P managed	364,000

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Feet

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Source: Esri World Imagery

STONE ENVIRONMENTAL

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TYPE II STONE RIP RAP FOR BANK STABILIZATION

PROPOSED 24" PVC SDR35 OVERFLOW

PROPOSED STORMDRAIN MANHOLE

PROPOSED 12" PVC SDR35 MANIFOLD

PROPOSED 6'ø DOWNSTREAM DEFENDER

PROPOSED CATCH BASIN

EXISTING CATCH BASIN STRUCTURE TO BE REMOVED

PROPOSED 18" STORMDRAIN

PROPOSED 12" PVC SDR35 PERFORATED (TYP. OF 5)

PROPOSED CATCH BASIN

CUT AND CAP (TYP.)

CUT AND CAP

PROPOSED 8'ø DRYWELL WITH FRAME AND GRATE

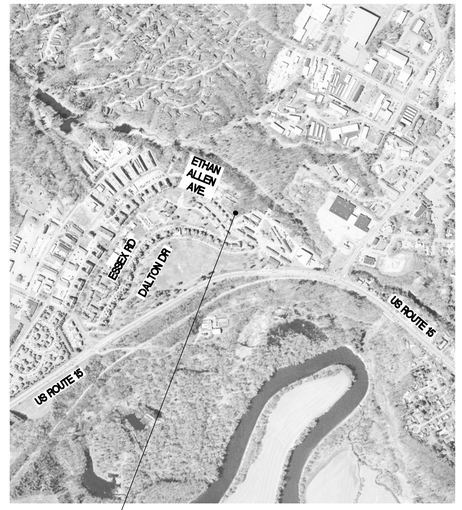
ETHAN ALLEN AVENUE

REPLACE EXISTING CATCH BASIN WITH NEW 8'ø DRYWELL WITH FRAME AND GRATE

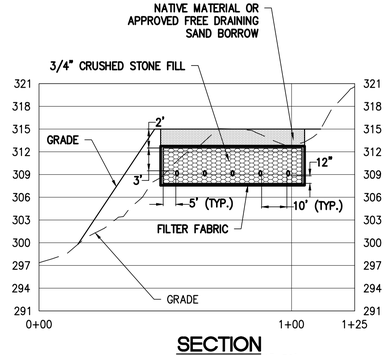
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GRAPHIC SCALE
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(IN FEET)



LOCATION MAP
SCALE: 1"=1000'



SECTION
SCALE: HORIZ. 1"=30'
VERT. 1"=3'

Aldrich + Elliott
WATER RESOURCE ENGINEERS
6 Market Place, Suite 2
Essex Jct., VT 05452
P: 802.879.7733
AEengineers.com

WATERSHED CONSULTING ASSOCIATES, LLC

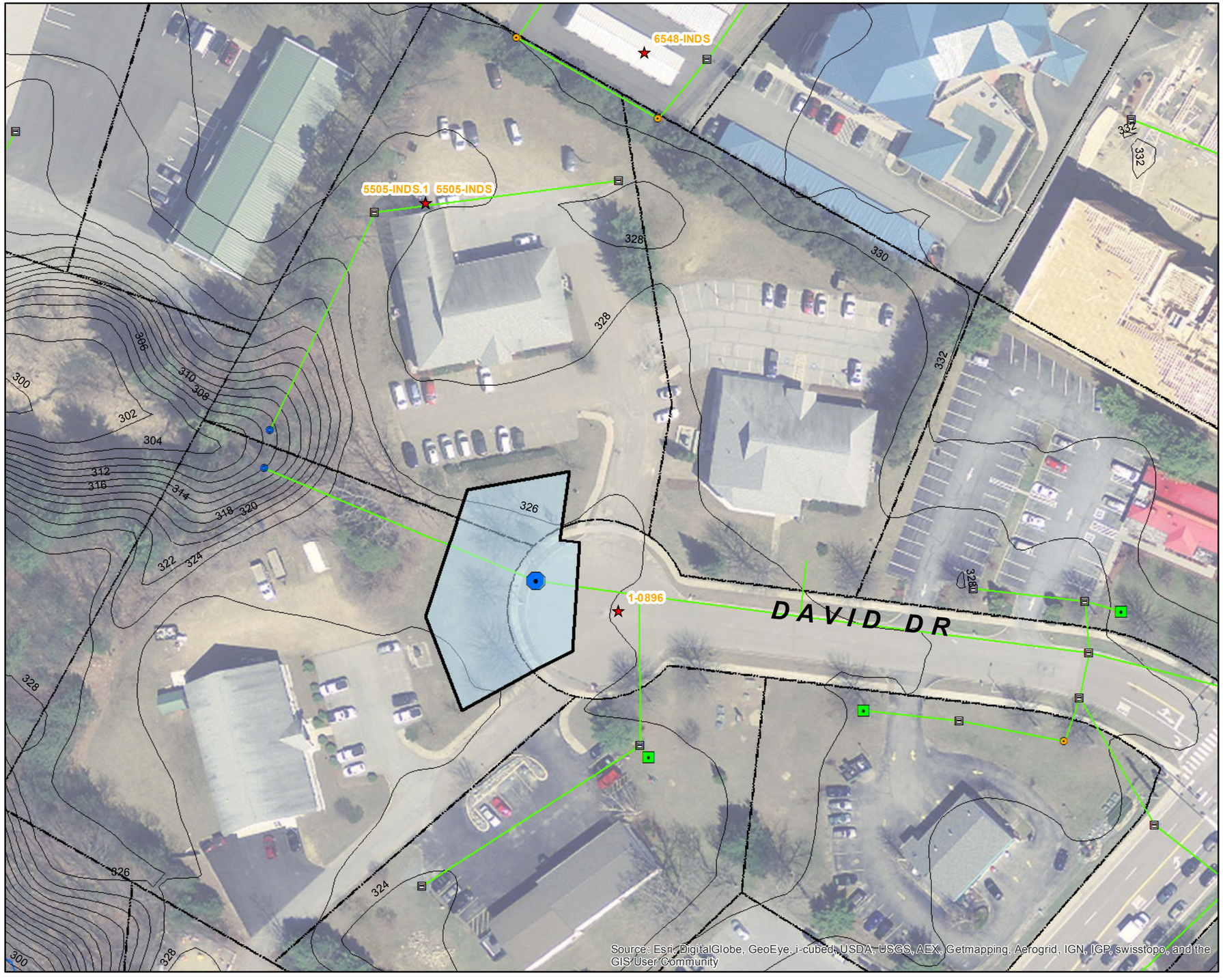
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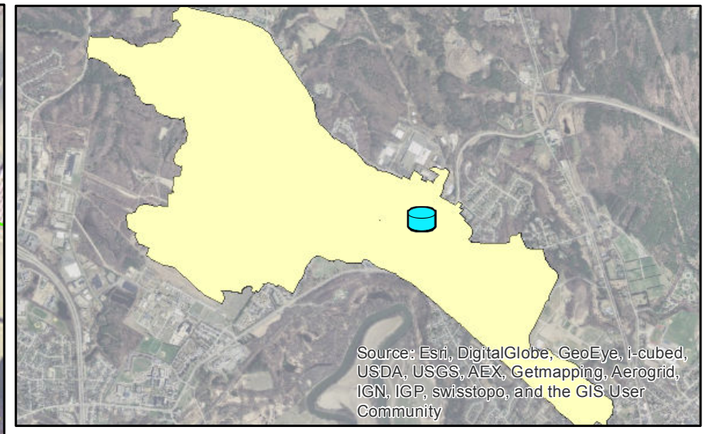
TOWN OF ESSEX, VERMONT

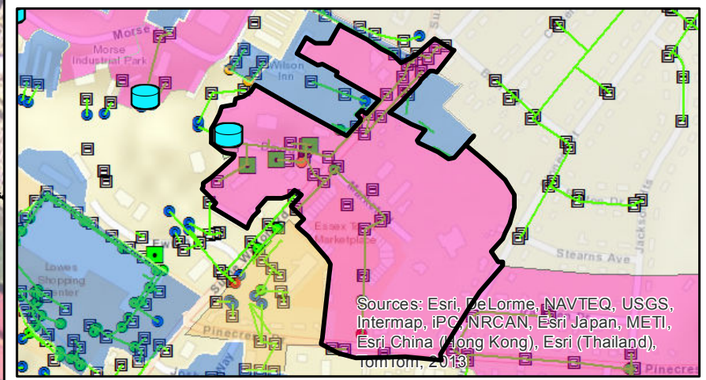
SUNDERLAND BROOK FRP

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DRAWN JEN	DRAWING 1
CHECKED WAE	
DATE FEB. 2015	

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LEGEND

- Permit
- PROPOSED STORM STRUCTURE
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Sunderland Brook

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed
- Outer Boundary

NOTES:

The proposed retrofit involves installation of an underground chamber system at the end of David Dr, using StormTech MC-3500 chambers. A flow splitter will route the 1-year storm to the chamber system, with high-flow bypass via the existing outfall. The existing bank will also be stabilized as a part of the project.

WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 Feet

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SUNDERLAND BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
David Dr. Underground Chamber System		
DATE: 2-6-15	***DRAWN BY:JS***	***SCALE:NOTED***

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake		Unique STP ID: EX-WR-001	
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	Meadows Edge/Steeplebush RETROFIT		
STP Latitude and Longitude: 44.51733, -73.061127			
STP Type: Gravel Wetland			

STP description:

Convert existing wet pond at Meadows Edge (3324-9010.R) into a gravel wetland

Feasibility constraints and comments:

Utility Conflicts: Gas, Cable, Sewer

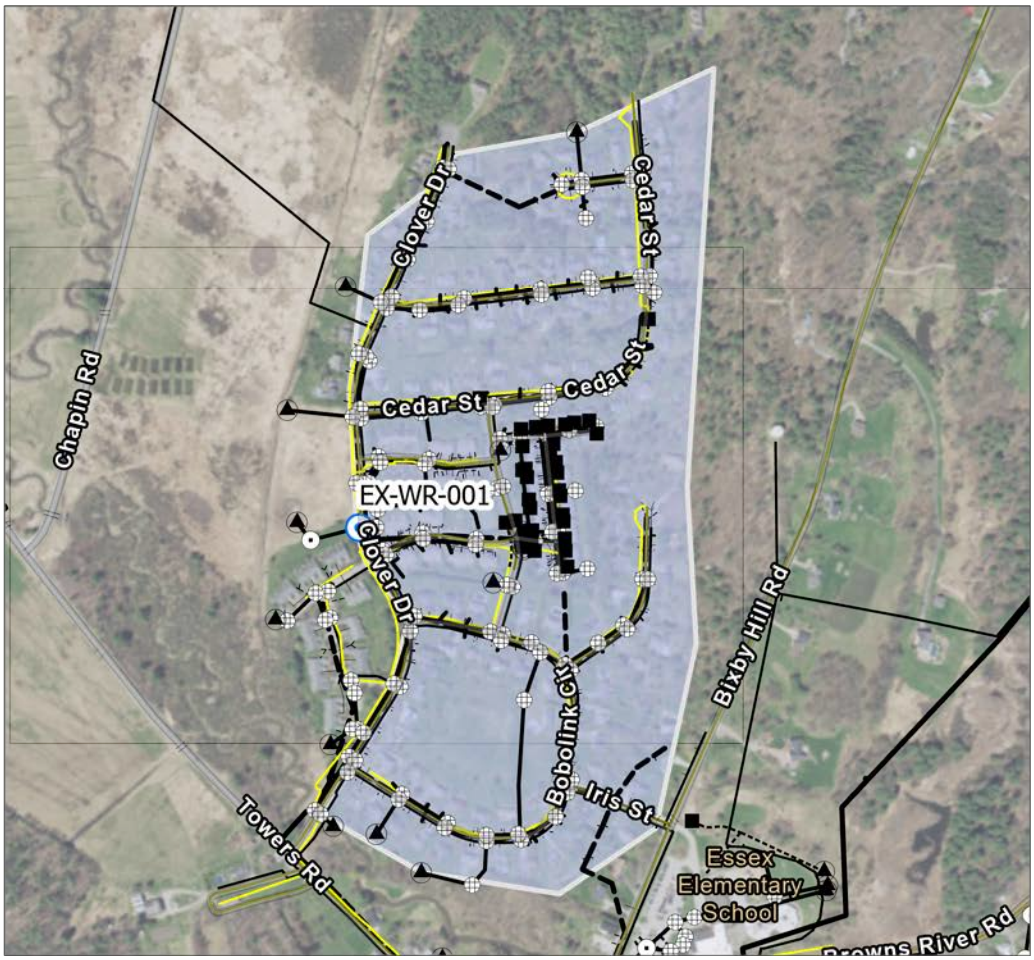
Comments:
Retrofit would result in substantially improved P load reduction

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$369,100.00
Total Drainage Area (acres)	68.09
Impervious area managed (acres)	6.59
Pervious area managed (acres)	61.5
Percent Impervious (%)	9.68%
Base P Load (kg/yr)	21.57
Hydrologic Soil Group (HSG)	Unknown
Water Quality volume managed (cubic feet)	21,711.03
Practice Efficiency (%)	42.21%
P Credit (kg/yr)	9.1
Infiltration Rate (inches/hr)	n/a
$ per acre of impervious managed	56,000
$ per kg of P managed	40,500

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake		Unique STP ID: EX-WR-002	
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	CB772-775 Foster Rd drywells		
STP Latitude and Longitude:	44.501823, -73.056099		
STP Type: Infiltration Trench			

STP description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints and comments:

Utility Conflicts: Gas, Cable, Sewer, Water lines

Comments:
Four catch basins and closed drainage flow to outlet 2OLET187 (ESSX051), which does not meet MRGP standards.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$91,200.00
Total Drainage Area (acres)	3.76
Impervious area managed (acres)	1.34
Pervious area managed (acres)	2.42
Percent Impervious (%)	35.64%
Base P Load (kg/yr)	1.55
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	4,559.28
Practice Efficiency (%)	99.48%
P Credit (kg/yr)	1.54
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	68,100
$ per kg of P managed	59,300

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EX-WR-003, EX-WR-004, EX-WR-005, EX-WR-006, EX-WR-007		
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	Saxonhollow		
Number of STPs:	5		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff. Total 13 catchbasins and five drainage areas in this project.

Feasibility constraints:

Utility Conflicts: Gas, Cable, Sewer, Water lines

Comments:

Closed drainage system flows to outlet 2OLET112 (ESSX062), where an existing practice failed in 2019 and the resulting gullying does not meet MRGP standards. Replacing the failed end-of-pipe STP is an option, though maintenance of the practice is challenging and the practice at the outlet will receive the same velocity and flow from upland runoff that caused the practice's failure.

Additional Project Benefits:

Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$205,300.00
Total Drainage Area (acres)	8.62
Impervious area managed (acres)	2.86
Pervious area managed (acres)	5.76
Percent Impervious (%)	33.18%
Base P Load (kg/yr)	3.31
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	10,251.12
Practice Efficiency (%)	99.33%
P Credit (kg/yr)	3.29
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	71,800
$ per kg of P managed	62,300

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake		Unique STP ID: EX-WR-008	
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	CB1046-1050 Sand Hill Rd drywells		
STP Latitude and Longitude:	44.485752, -73.049591		
STP Type: Infiltration Trench			

STP description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints and comments:

Utility Conflicts: Cable, Sewer, Water lines

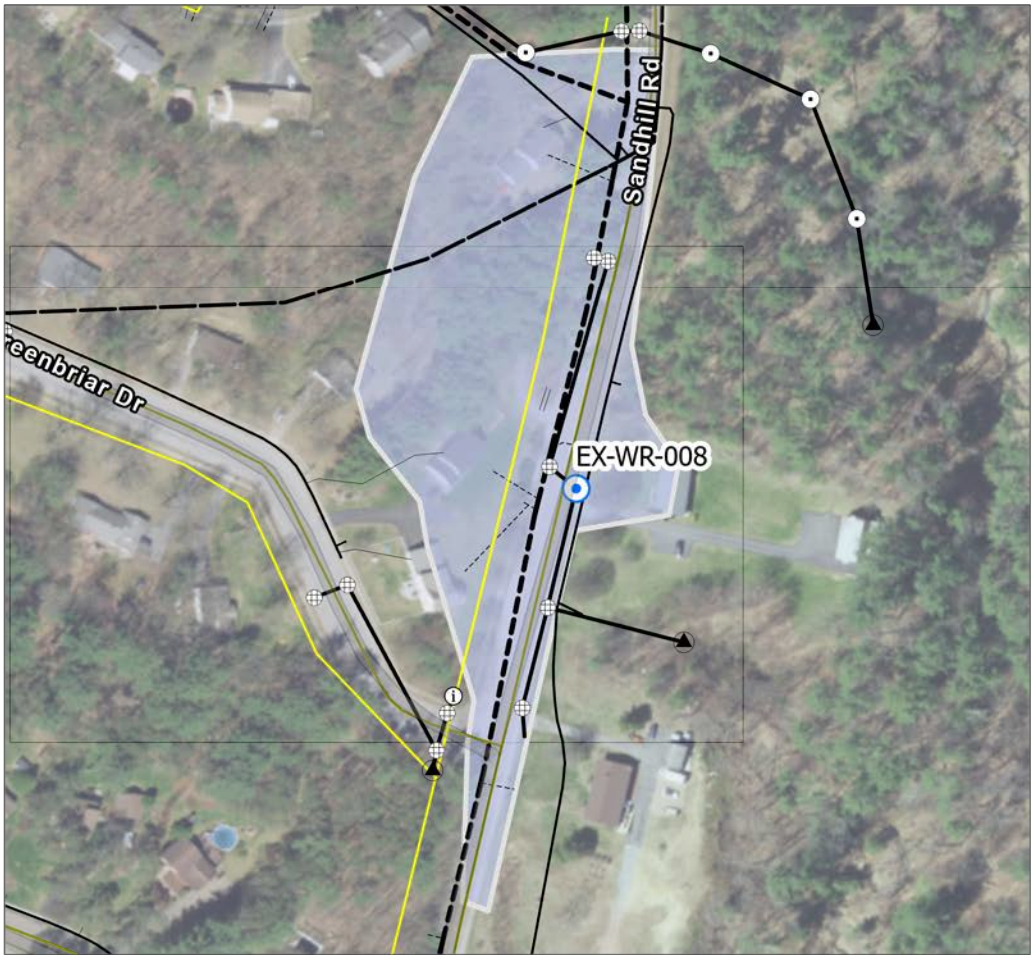
Comments:
Closed drainage system flows to outlet 2OLET135 (ESSX043), which partially meets MRGP standards.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$60,500.00
Total Drainage Area (acres)	3.36
Impervious area managed (acres)	0.87
Pervious area managed (acres)	2.49
Percent Impervious (%)	25.89%
Base P Load (kg/yr)	1.02
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	3,023.79
Practice Efficiency (%)	99.47%
P Credit (kg/yr)	1.02
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	69,500
$ per kg of P managed	59,500

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake		Unique STP ID: EX-WR-009	
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	CB957-960 Greenbriar Dr drywells		
STP Latitude and Longitude:	44.485481, -73.050461		
STP Type: Infiltration Trench			

STP description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints and comments:

Utility Conflicts: Cable, Sewer

Comments:
Closed drainage system flows to outlet 2OLET186 (ESSX042), which exhibits rill erosion and only partially meets MRGP standards.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$54,000.00
Total Drainage Area (acres)	1.99
Impervious area managed (acres)	0.77
Pervious area managed (acres)	1.22
Percent Impervious (%)	38.69%
Base P Load (kg/yr)	0.88
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	2,697.09
Practice Efficiency (%)	99.63%
P Credit (kg/yr)	0.88
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	70,100
$ per kg of P managed	61,300

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	EX-WR-010
Drainage Area:	Winooski River	**Responsible Party:**	Essex Town MS4
Project Name:	CB964 968-970 Greenfield Rd drywells		
STP Latitude and Longitude:	44.483299, -73.057213		
STP Type:	Infiltration Trench		

STP description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints and comments:

Utility Conflicts: Cable, Sewer, Water lines

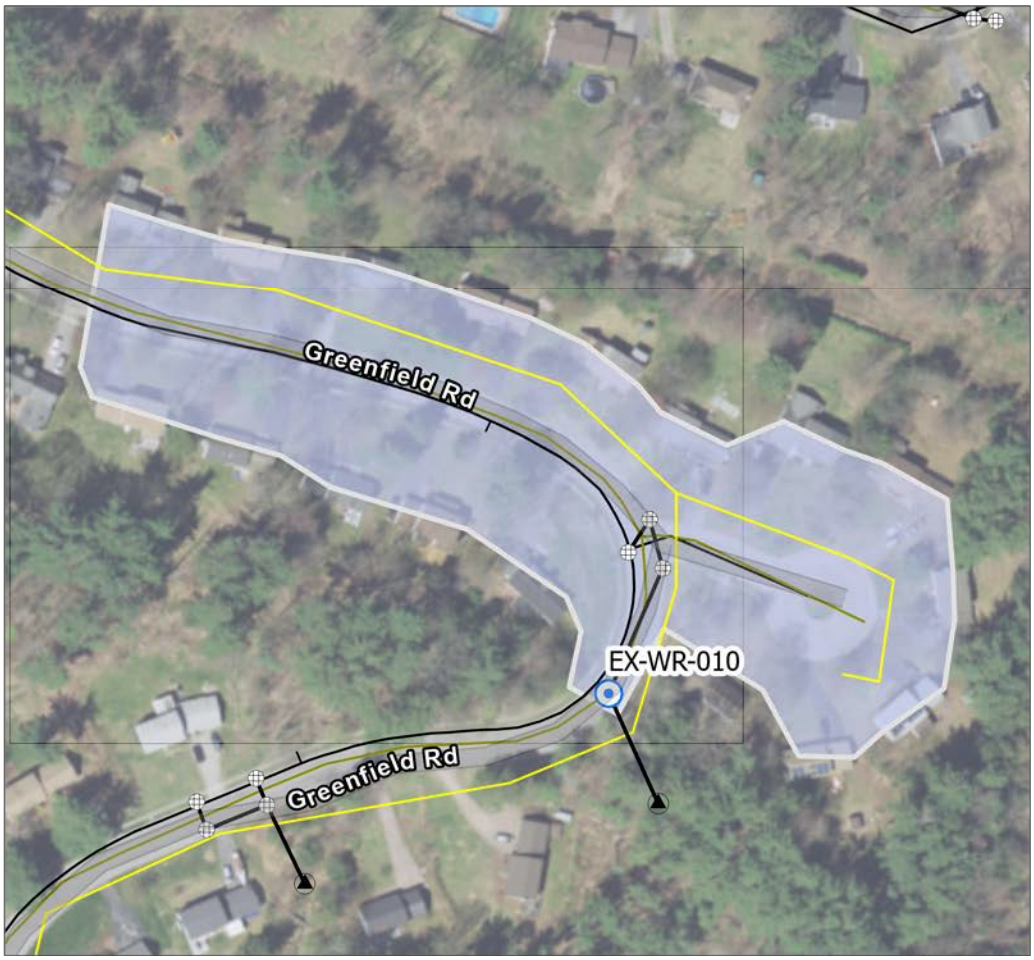
Comments:
Closed drainage system flows to outlet 2OLET118 (ESSX064), which does not meet MRGP standards.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$74,900.00
Total Drainage Area (acres)	3.62
Impervious area managed (acres)	1.09
Pervious area managed (acres)	2.53
Percent Impervious (%)	30.11%
Base P Load (kg/yr)	1.86
Hydrologic Soil Group (HSG)	Developed Pervious - B
Water Quality volume managed (cubic feet)	3,742.53
Practice Efficiency (%)	93.53%
P Credit (kg/yr)	1.74
Infiltration Rate (inches/hr)	1.02 in/hr
$ per acre of impervious managed	68,700
$ per kg of P managed	43,100

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EX-WR-011, EX-WR-012		
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	Wildwood		
Number of STPs:	2		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Cable, Sewer, Water lines

Comments:
Two drainage areas and sets of catch basins in this project, each of which flows to a separate outlet. Outlets 2OLET152 (ESSX036) and 2OLET153 (ESSX035) do not meet MRGP standards.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$37,700.00
Total Drainage Area (acres)	1.36
Impervious area managed (acres)	0.46
Pervious area managed (acres)	0.9
Percent Impervious (%)	34.07%
Base P Load (kg/yr)	0.72
Hydrologic Soil Group (HSG)	Developed Pervious - B
Water Quality volume managed (cubic feet)	1,882.15
Practice Efficiency (%)	96.18%
P Credit (kg/yr)	0.7
Infiltration Rate (inches/hr)	1.02 in/hr
$ per acre of impervious managed	81,100
$ per kg of P managed	54,100

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	EX-WR-039
Drainage Area:	Winooski River	**Responsible Party:**	Essex Town MS4
Project Name:	2OLET88 Tanglewood Drive and Fern Hollow Road retrofits (Alternative 4)		
STP Latitude and Longitude:	44.504353, -73.062965		
STP Type:	Dry Swale (w/ underdrain)		

STP description:

Implement strategic drainage and stormwater management retrofits along Tanglewood Drive and Fern Hollow Road consistent with outcomes of Tanglewood Drive Stormwater/Pedestrian Improvements Study, Tanglewood Drive, Cindy Lane to Woodlawn.

Feasibility constraints and comments:

Utility Conflicts:

Comments:
In March 2021 the Town indicated that the likely outcome was relining pipes on Tanglewood Drive and installing a storage and infiltration system at the bottom of Fern Hollow.

Additional Project Benefits:
The project would provide runoff storage and water quality treatment, reduce velocity and flow at outlet 2OLET88.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$410,000.00
Total Drainage Area (acres)	18.16
Impervious area managed (acres)	6.66
Pervious area managed (acres)	11.5
Percent Impervious (%)	36.67%
Base P Load (kg/yr)	10.1
Hydrologic Soil Group (HSG)	Unknown
Water Quality volume managed (cubic feet)	18,774.36
Practice Efficiency (%)	44.00%
P Credit (kg/yr)	4.44
Infiltration Rate (inches/hr)	n/a
$ per acre of impervious managed	61,600
$ per kg of P managed	92,300

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	EX-WR-040
Drainage Area:	Winooski River	**Responsible Party:**	Essex Town MS4
Project Name:	2OLET56 Craftsbury Court pond retrofit		
STP Latitude and Longitude:	44.511322, -73.079109		
STP Type:	Gravel Wetland		

STP description:

Retrofit existing dry extended detention pond into a gravel wetland within present footprint.

Feasibility constraints and comments:

Utility Conflicts:

Comments:
Historical photos do not indicate permanent pool in pond and construction before mid-1990s. Construction and maintenance access appears straightforward.

Additional Project Benefits:
Adjacent to multi-use path, educational/demonstration opportunity.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$341,700.00
Total Drainage Area (acres)	9.74
Impervious area managed (acres)	2.55
Pervious area managed (acres)	7.19
Percent Impervious (%)	26.18%
Base P Load (kg/yr)	5.51
Hydrologic Soil Group (HSG)	Developed Pervious - C
Water Quality volume managed (cubic feet)	20,100
Practice Efficiency (%)	62.96%
P Credit (kg/yr)	2.81
Infiltration Rate (inches/hr)	n/a
$ per acre of impervious managed	134,000
$ per kg of P managed	122,000

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EX-WR-041, EX-WR-042, EX-WR-043		
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	Logwood Circle		
Number of STPs:	3		
STP Types:	Infiltration Trench		

Project description:

Replace stormlines identified in 2020 televised inventory as needing replacement with perforated pipe in gravel bedding. Consider catchbasin replacments with drywells in same project.

Feasibility constraints:

Utility Conflicts: Cable, Water lines

Comments:
Stormlines identified as failing included lines between CB975-977 and 977 to 979-980. Since existing stormlines will be replaced in existing alignment utility conflicts are anticipated to be minimal.

Additional Project Benefits:
Water quality improvement, and reduction in runoff flow and velocity reaching system outlet.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$278,600.00
Total Drainage Area (acres)	13.88
Impervious area managed (acres)	3.53
Pervious area managed (acres)	10.35
Percent Impervious (%)	25.43%
Base P Load (kg/yr)	4.32
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	13,922.86
Practice Efficiency (%)	97.96%
P Credit (kg/yr)	4.23
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	78,900
$ per kg of P managed	65,900

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs:	EJ-WR-004, EJ-WR-005, EJ-WR-006, EJ-WR-007, EJ-WR-008	
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Camp Street		
Number of STPs:	5		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Gas, Cable, Sewer, Water lines

Comments:
Street is uncurbed with no sidewalks. Overhead electric and telecom on west side of street; less direct conflict with catch-basin locations compared to Elm Street.

Additional Project Benefits:
Opportunity to apply a distributed, "invisible green infrastructure" approach at the street scale.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$58,500.00
Total Drainage Area (acres)	1.83
Impervious area managed (acres)	0.79
Pervious area managed (acres)	1.04
Percent Impervious (%)	43.17%
Base P Load (kg/yr)	0.9
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	2,913.07
Practice Efficiency (%)	97.84%
P Credit (kg/yr)	0.88
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	74,100
$ per kg of P managed	66,200

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



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Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs:	EJ-WR-017, EJ-WR-018, EJ-WR-019, EJ-WR-020, EJ-WR-021	
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Elm Street		
Number of STPs:	5		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Gas, Cable, Sewer, Water lines

Comments:
Street is uncurbed with no sidewalks. Catchbasins on west side of street offset from road and often immediately beneath overhead electric and telecom.

Additional Project Benefits:
Opportunity to apply a distributed, "invisible green infrastructure" approach at the street scale.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$178,100.00
Total Drainage Area (acres)	4
Impervious area managed (acres)	2.5
Pervious area managed (acres)	1.5
Percent Impervious (%)	62.5%
Base P Load (kg/yr)	2.82
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	8,893.5
Practice Efficiency (%)	98.63%
P Credit (kg/yr)	2.8
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	71,200
$ per kg of P managed	63,600

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



0 100
Feet

N

Path: O:\PROJ-18\WRM\18-123 Essex PCP\Data\GIS\MapDocuments\PresentationsAndReports\STP summary sheets\STP_summary_sheets\STP_summary_sheets.aprx Grouped_STPS
Modified: 3/23/2021 3:06 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EJ-WR-009, EJ-WR-010, EJ-WR-011, EJ-WR-012, EJ-WR-013, EJ-WR-014, EJ-WR-015, EJ-WR-016		
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Jackson Street		
Number of STPs:	8		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Gas, Cable, Sewer, Water lines

Comments:
Street is uncurbed with no sidewalks. Catchbasins on south side of street sometimes beneath overhead electric and telecom.

Additional Project Benefits:
Opportunity to apply a distributed, "invisible green infrastructure" approach at the street scale.

Proposed STP details:

Estimated Project Cost (2021 dollars)	$178,300.00
Total Drainage Area (acres)	5.39
Impervious area managed (acres)	2.42
Pervious area managed (acres)	2.97
Percent Impervious (%)	44.9%
Base P Load (kg/yr)	2.76
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	8,884.43
Practice Efficiency (%)	98.05%
P Credit (kg/yr)	2.71
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	73,700
$ per kg of P managed	65,700

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



0 100
Feet

N

Path: O:\PROJ-18\WRM\18-123 Essex PCP\Data\GIS\MapDocuments\PresentationsAndReports\STP summary sheets\STP_summary_sheets\STP_summary_sheets.aprx Grouped_STPS
Modified: 3/24/2021 5:43 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake	List of STP IDs: EJ-WR-002, EJ-WR-003		
Drainage Area:	Winooski River	Responsible Party:	Essex Junction MS4
Project Name:	Oak Street		
Number of STPs:	2		
STP Types:	Infiltration Trench		

Project description:

Install subsurface drywells in existing catchbasin footprints, or retain catchbasins but attach them to subsurface infiltration chambers to infiltrate roadway runoff.

Feasibility constraints:

Utility Conflicts: Gas, Cable

Comments:
Two sets of catch-basins along this street, but no cul-de-sac exists here so no opportunity for impervious removal. No curbing; electric+telecom are overhead.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$33,600.00
Total Drainage Area (acres)	0.94
Impervious area managed (acres)	0.46
Pervious area managed (acres)	0.48
Percent Impervious (%)	48.94%
Base P Load (kg/yr)	0.52
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	1,673.43
Practice Efficiency (%)	99.87%
P Credit (kg/yr)	0.52
Infiltration Rate (inches/hr)	8.27 in/hr
$ per acre of impervious managed	73,000
$ per kg of P managed	64,300

Site map



LEGEND

- STP Locations
- STP Drainage Areas
- Cable Lines
- Gas Lines

Essex Town Water Lines (Essex Town)

- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



0 100
Feet

N

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Modified: 3/24/2021 5:25 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment: Main Lake		Unique STP ID: 3579-9010.R	
Drainage Area:	Winooski River	Responsible Party:	Essex Town MS4
Project Name:	Old Stage Village RETROFIT		
STP Latitude and Longitude: 44.515896, -73.077728			
STP Type: Dry Swale (infiltrating)			

STP description:

Convert existing grass swales in the Old Stage Village Development (3579-9010.R) into dry swales

Feasibility constraints and comments:

Utility Conflicts: Gas, Sewer

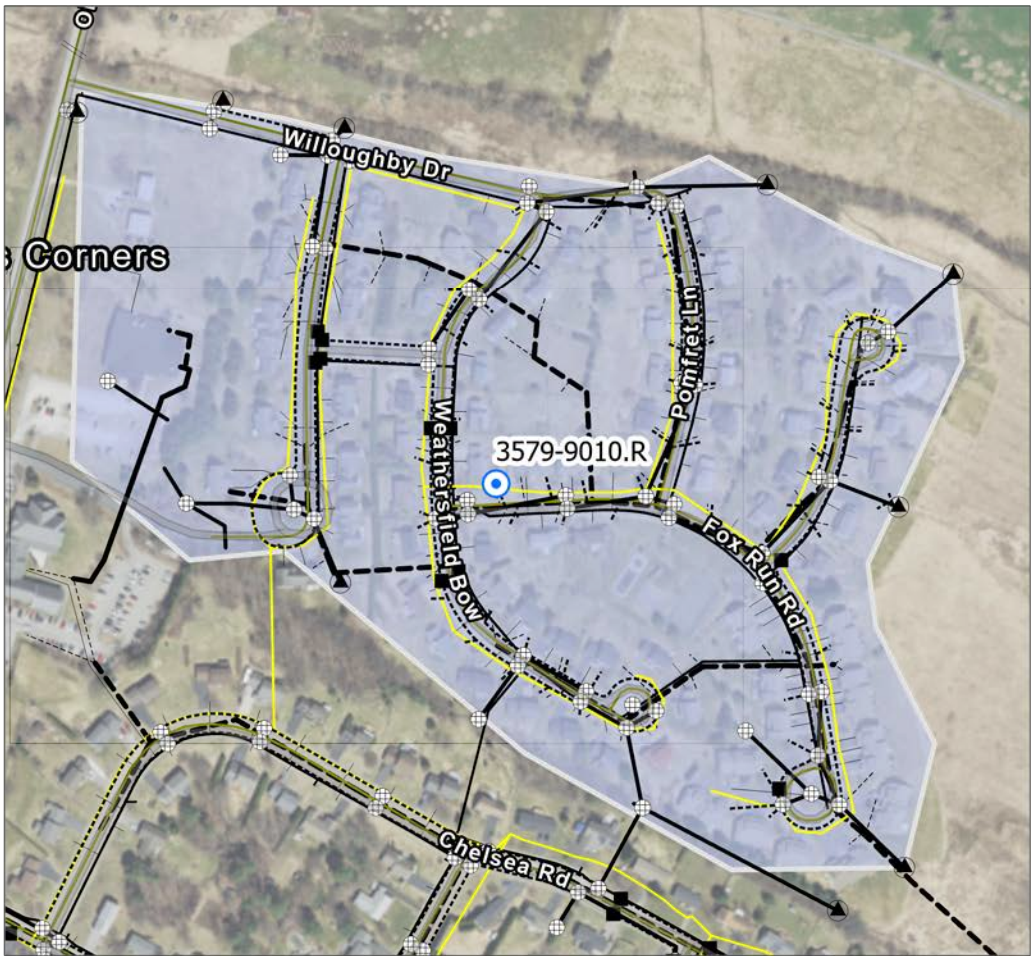
Comments:
While maintenance of the existing swales is needed, soils have limited suitability for infiltration; and open space for construction of STPs outside of the existing grass channels is limited

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$235,300.00
Total Drainage Area (acres)	37.78
Impervious area managed (acres)	4.18
Pervious area managed (acres)	33.6
Percent Impervious (%)	11.06%
Base P Load (kg/yr)	12.43
Hydrologic Soil Group (HSG)	Unknown
Water Quality volume managed (cubic feet)	13,837.56
Practice Efficiency (%)	88.68%
P Credit (kg/yr)	11.02
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	56,300
$ per kg of P managed	21,300

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



0 300 600 900

Feet

N

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Modified: 3/23/2021 2:37 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Malletts Bay	**Unique STP ID:**	EJ-MB-001
Drainage Area:	Malletts Bay Direct Drainage	**Responsible Party:**	Essex Junction MS4
Project Name:	Briar Lane Impervious Removal		
STP Latitude and Longitude:	44.488014, -73.088051		
STP Type:	Impervious removal		

STP description:

Remove paved road remaining following extension of road through cul-de-sac.

Feasibility constraints and comments:

Utility Conflicts: Gas, Sewer

Comments:
Just north of the Winooski-Malletts Bay watershed boundary. Low priority.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$2,500.00
Total Drainage Area (acres)	0.34
Impervious area managed (acres)	0.17
Pervious area managed (acres)	0.17
Percent Impervious (%)	50%
Base P Load (kg/yr)	0.14
Hydrologic Soil Group (HSG)	Developed Pervious - A
Water Quality volume managed (cubic feet)	n/a
Practice Efficiency (%)	98.51%
P Credit (kg/yr)	0.14
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	14,700
$ per kg of P managed	17,900

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



0 100 200 300

Feet

N

Path: O:\PROJ-18\WRM\18-123 Essex PCP\Data\GIS\MapDocuments\PresentationsAndReports\STP summary sheets\STP_summary_sheets\STP_summary_sheets.aprx Individual_Planned_STPs
Modified: 3/23/2021 12:59 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	EJ-WR-001
Drainage Area:	Winooski River	**Responsible Party:**	Essex Junction MS4
Project Name:	Maplewood Lane cul-de-sac		
STP Latitude and Longitude:	44.488754, -73.099358		
STP Type:	Sand filter (w/ underdrain)		

STP description:

Cul de sac and impervious removal; similar to Oakwood Dr but with smaller drainage area.

Feasibility constraints and comments:

Utility Conflicts: Cable, Sewer

Comments:

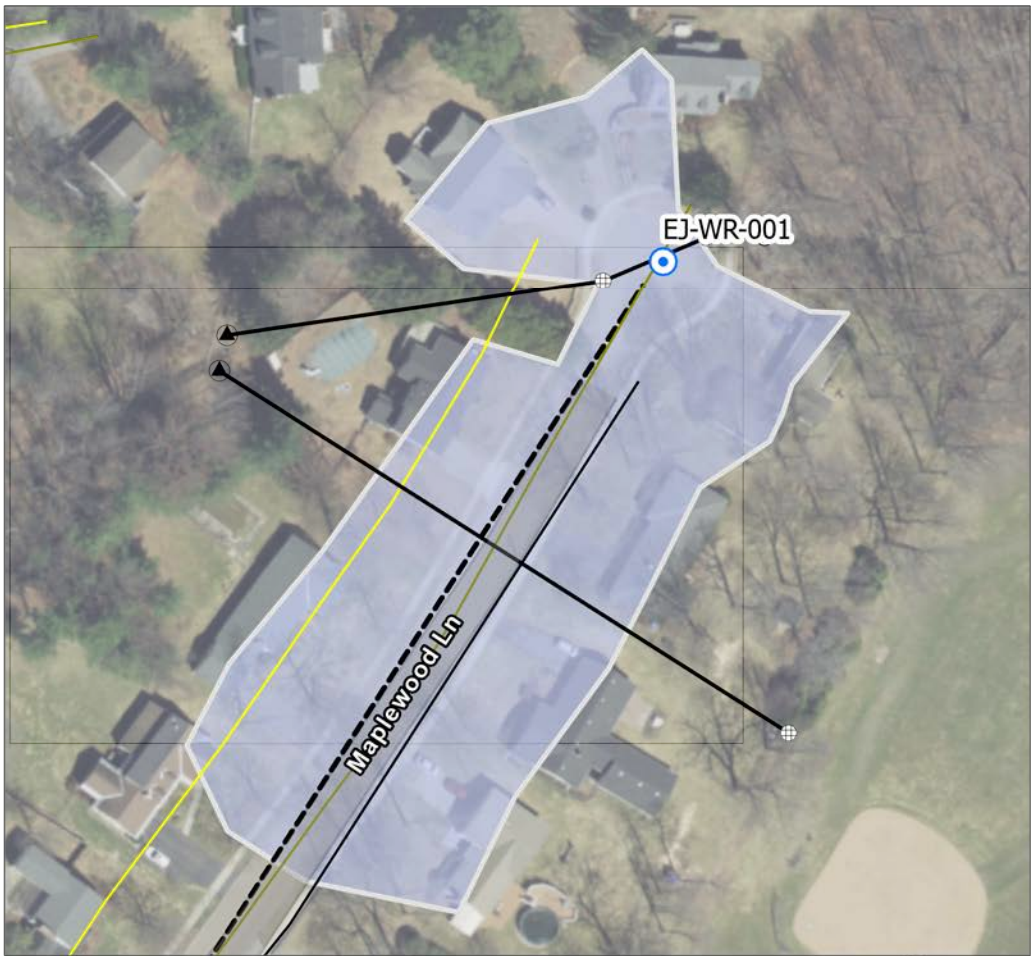
Soils finely textured, assume sand/enhanced filter. Culverted stream crossing under cul-de-sac. Cul-de-sac is 65' diameter; impervious removal may not be feasible in terms of emergency vehicle access/turning radii.

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$49,300.00
Total Drainage Area (acres)	1.72
Impervious area managed (acres)	0.6
Pervious area managed (acres)	1.12
Percent Impervious (%)	34.88%
Base P Load (kg/yr)	1.01
Hydrologic Soil Group (HSG)	Developed Pervious - B
Water Quality volume managed (cubic feet)	2,141.7
Practice Efficiency (%)	49.36%
P Credit (kg/yr)	0.5
Infiltration Rate (inches/hr)	n/a
$ per acre of impervious managed	82,200
$ per kg of P managed	98,900

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V



0 100 200 300

Feet

N

Path: O:\PROJ-18\WRM\18-123 Essex PCP\Data\GIS\MapDocuments\PresentationsAndReports\STP summary sheets\STP_summary_sheets\STP_summary_sheets.aprx Individual_Planned_STPs
Modified: 3/23/2021 1:57 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Essex Junction and Essex Town PCPs Structural STP Summary

Lake Segment:	Main Lake	**Unique STP ID:**	3081-9010.R
Drainage Area:	Winooski River	**Responsible Party:**	Essex Town MS4
Project Name:	Perkins Bend 002 impervious removal		
STP Latitude and Longitude:	44.483624, -73.069664		
STP Type:	Impervious removal		

STP description:

Impervious removal for two cul de sacs in this subdivision with relict impervious, subdivisions have been extended past the former turnarounds.

Feasibility constraints and comments:

Utility Conflicts:

Comments:

Additional Project Benefits:

Proposed STP details:

Estimated Project Cost (2021 dollars)	$2,500.00
Total Drainage Area (acres)	0.28
Impervious area managed (acres)	0.28
Pervious area managed (acres)	0
Percent Impervious (%)	100%
Base P Load (kg/yr)	0.31
Hydrologic Soil Group (HSG)	Unknown
Water Quality volume managed (cubic feet)	n/a
Practice Efficiency (%)	95.92%
P Credit (kg/yr)	0.3
Infiltration Rate (inches/hr)	2.41 in/hr
$ per acre of impervious managed	8,930
$ per kg of P managed	8,330

Site map



LEGEND

- STP Locations
- Cable Lines
- Gas Lines
- STP Drainage Areas

Essex Town Water Lines (Essex Town)

- HYD, C; HYD, CWD; HYD, PT; HYD, T
- MAIN, CWD
- MAIN, PT; MAIN, T; MAIN, PV; MAIN, V
- SRVC, CWD; SRVC, PT; SRVC, T



0 100 200 300

Feet

N

Path: O:\PROJ-18\WRM\18-123 Essex PCP\Data\GIS\MapDocuments\PresentationsAndReports\STP summary sheets\STP_summary_sheets\STP_summary_sheets.aprx Individual_Planned_STPs
Modified: 3/23/2021 12:55 PM by hcox

Source: Esri World Imagery

STONE ENVIRONMENTAL

Appendix C – Credit Calculation Details for Road Drainage Outlet Stabilization BMPs

Update: 02/26/2021 anm - checked spreadsheet against updated GIS data following 12/2020 memo submittal

03/26/2021 anm - added Essex outlet ID to this table for cross-walk with PCP and Town-Village data

								Equation 1: Rate of Erosion, E = (VS)/T								Equation 2: Phosphorus Loading Rate, Pi = E (Sc)		Equation 3: Phosphorus Reduction, Pf = Pi - Pii	
											V		S	T	E	Sc	Pi	Pii	Pf
MS4	Outlet Unique ID	Essex Outlet ID	Lake Drainage Area	Erosion type	Slope (%)	Assessment Reason	Meets Standards?	Erosion length measured from outlet (ft)	Erosion width (ft)	Erosion depth (ft)	Erosion Volume From Outlet (ft3)	Erosion Volume (yd3)	Sediment bulk density (kg/ft3)	Age of erosion observed (yrs)	Sediment erosion rate (kg sediment/yr)	Sediment to phosphorus weight converstion (kg P/kg sediment)	P loading rate, pre-mitigation (kg/year)	P loading rate, post-mitigation (kg P/year)	Difference in P loading rate, calculated only when outlet erodes post-mitigation (?) (kg P/yr)
ESSEX	ESSX022	2OLET239	Lamoille River	Rill	46.63	Re Assessmer	Partially Meets	0	0	0	27	1	43.38	30	39	0.000396	0.015	0	0.015
ESSEX	ESSX026	2OLET065	Winooski River	Gully	46.63	Re Assessmer	Fully Meets	0	0	0	2,322	86	43.38	30	3,358	0.000396	1.330	0	1.330
ESSEX	ESSX031	2OLET150	Winooski River	Gully	10.51	Re Assessmer	Does Not Meet	0	0	0	243	9	43.38	30	351	0.000396	0.139	0	0.139
ESSEX	ESSX035	2OLET153	Winooski River	Gully	17.63	Re Assessmer	Does Not Meet	0	0	0	108	4	43.38	30	156	0.000396	0.062	0	0.062
ESSEX	ESSX036	2OLET152	Winooski River	Rill	3.49	Re Assessmer	Partially Meets	0	0	0	54	2	43.38	30	78	0.000396	0.031	0	0.031
ESSEX	ESSX042	2OLET186	Winooski River	Rill	46.63	Re Assessmer	Partially Meets	0	0	0	54	2	43.38	30	78	0.000396	0.031	0	0.031
ESSEX	ESSX043	2OLET135	Winooski River	Gully	10.51	Re Assessmer	Does Not Meet	0	0	0	270	10	43.38	30	390	0.000396	0.155	0	0.155
ESSEX	ESSX051	2OLET187	Winooski River	Gully	46.63	Re Assessmer	Does Not Meet	0	0	0	216	8	43.38	30	312	0.000396	0.124	0	0.124
ESSEX	ESSX053	2OLET068	Lamoille River	Gully	10.51	Re Assessmer	Does Not Meet	0	0	0	405	15	43.38	30	586	0.000396	0.232	0	0.232
ESSEX	ESSX056	2OLET171	Winooski River	Rill	12.28	Re Assessmer	Partially Meets	0	0	0	27	1	43.38	30	39	0.000396	0.015	0	0.015
ESSEX	ESSX062	2OLET112	Winooski River	None	23.09	Re Assessmer	Does Not Meet	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX	ESSX064	2OLET118	Winooski River	Gully	8.75	Re Assessmer	Does Not Meet	0	0	0	1,215	45	43.38	30	1,757	0.000396	0.696	0	0.696
ESSEX	ESSX066	2OLET172	Winooski River	Rill	4.37	Re Assessmer	Partially Meets	0	0	0	54	2	43.38	30	78	0.000396	0.031	0	0.031
ESSEX JUNCTION VILLAGE	EJCT050	1OLET1134	Malletts Bay - DD	None	0.00	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX JUNCTION VILLAGE	EJCT055	1OLET1085	Malletts Bay - DD	Rill	3.49	Re Assessmer	Partially Meets	16	7	0.8	90	3	43.38	30	130	0.000396	0.051	0	0.051
ESSEX JUNCTION VILLAGE	EJCT045	1OLET1154	Malletts Bay - DD	None	46.63	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX JUNCTION VILLAGE	EJCT039	1OLET1158	Malletts Bay - DD	None	3.49	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX JUNCTION VILLAGE	EJCT065	1OLET1074	Malletts Bay - DD	Gully	46.63	Initial Invento	Does Not Meet	30	20	8	4,800	178	43.38	30	6,941	0.000396	2.749	0	2.749
ESSEX JUNCTION VILLAGE	EJCT066	1OLET1073	Malletts Bay - DD	Gully	46.63	Initial Invento	Does Not Meet	9	10	2	180	7	43.38	30	260	0.000396	0.103	0	0.103
ESSEX JUNCTION VILLAGE	EJCT034	1OLET1149	Malletts Bay - DD	Gully	3.49	Re Assessmer	Does Not Meet	70	6.6	2.5	1,155	43	43.38	30	1,670	0.000396	0.661	0	0.661
ESSEX JUNCTION VILLAGE	EJCT057	1OLET1091	Malletts Bay - DD	None	2.16	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX JUNCTION VILLAGE	EJCT056	1OLET1091	Malletts Bay - DD	None	2.16	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000
ESSEX JUNCTION VILLAGE	EJCT090	1OLET1023	Winooski River	Gully	0.00	Re Assessmer	Does Not Meet	11	5	3	165	6	43.38	30	239	0.000396	0.094	0	0.094
ESSEX JUNCTION VILLAGE	EJCT076	1OLET1117	Winooski River	Gully	46.63	Re Assessmer	Does Not Meet	16	7	3	336	12	43.38	30	486	0.000396	0.192	0	0.192
ESSEX JUNCTION VILLAGE	EJCT015	1OLET1146	Malletts Bay - DD	None	5.24	Re Assessmer	Fully Meets	0	0	0	-	-	43.38	30	-	0.000396	0.000	0	0.000

Appendix D - Street Sweeping Route Maps and Details

Winooski River

Malletts Bay - DD

VT-15

VT-2A

VT-117

Sweeper Routes > 17% forested

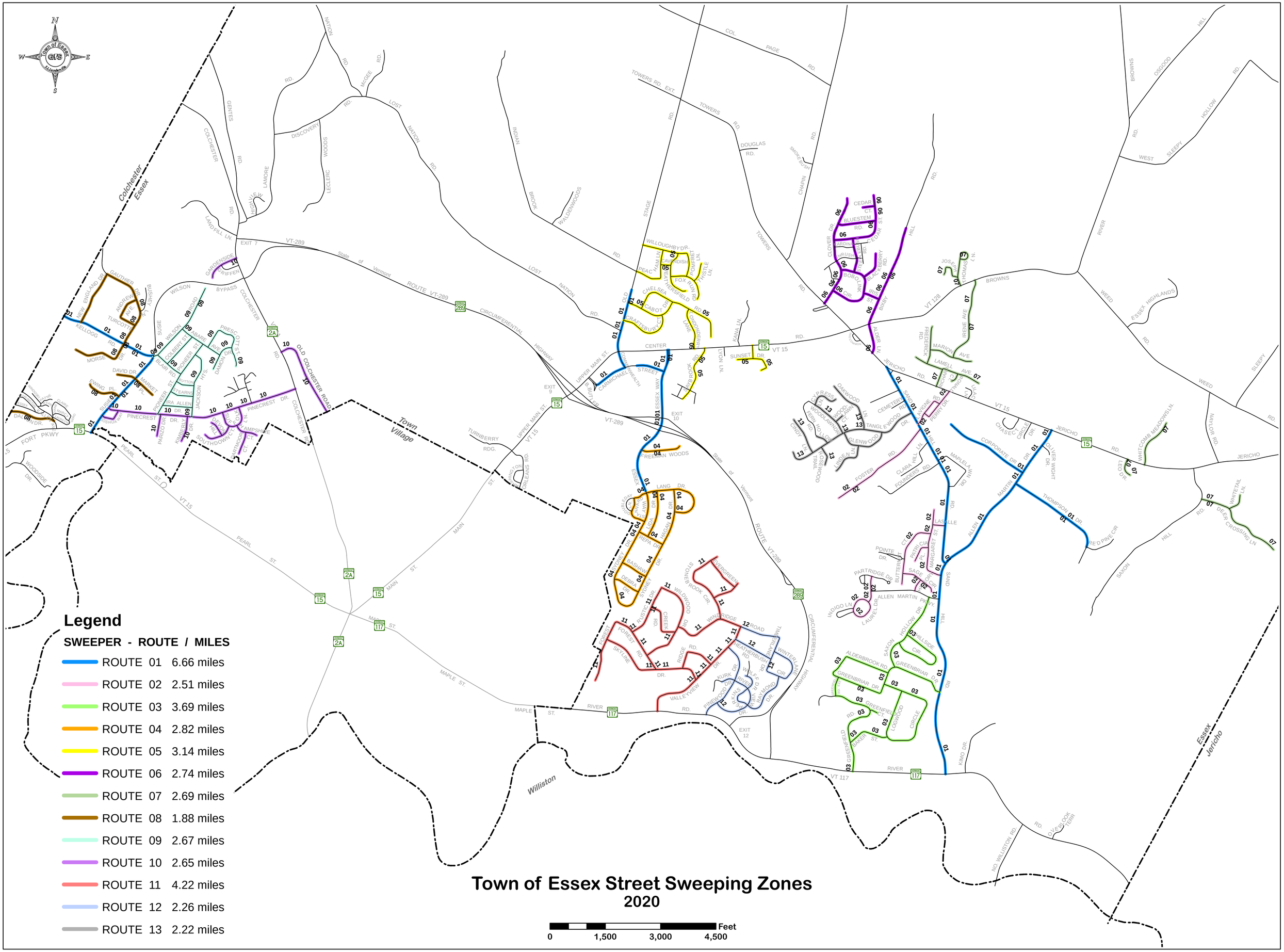
- Malletts Bay - DD (Malletts Bay), Green
- Winooski River (Main Lake), Green
- Winooski River (Main Lake), Blue

Sweeper Routes < 17% forested

- Winooski River (Main Lake), Red
- Malletts Bay - DD (Malletts Bay), Red

Essex Junction Sweeper Routes

N


Legend
SWEEPER - ROUTE / MILES
ROUTE 01 6.66 miles
ROUTE 02 2.51 miles
ROUTE 03 3.69 miles
ROUTE 04 2.82 miles
ROUTE 05 3.14 miles
ROUTE 06 2.74 miles
ROUTE 07 2.69 miles
ROUTE 08 1.88 miles
ROUTE 09 2.67 miles
ROUTE 10 2.65 miles
ROUTE 11 4.22 miles
ROUTE 12 2.26 miles
ROUTE 13 2.22 miles
Town of Essex Street Sweeping Zones
2020
0
1,500
3,000
4,500
Feet
Colchester
Essex
Town
Village
Williston
Essex
Jericho
VT-289
VT 15
VT 117
VT 128
EXIT 7
EXIT 9
EXIT 10
EXIT 12
CIRCUMFERENTIAL HIGHWAY
ROUTE VT-289
State of Vermont
OLD COLCHESTER ROAD
CENTER STREET
UPPER MAIN ST.
LOWER MAIN ST.
MAIN ST.
MAPLE ST.
PEARL ST.
FORT PKWY
JERICHO RD.
JUNCTION RD.
TOWERS RD.
LOST NATION RD.
WEST SLEEPY HOLLOW RD.
BROWNS RIVER
WEED RD.
ESSEX HIGHLANDS
SUNSET DR.
CARMICHAEL ST.
COMMONWEALTH AVE.
PINECREST DR.
SAND HILL
ALLEN MARTIN PKWY
CORPORATE DR.
THOMPSON DR.
RED PINE CIR.
FREEMAN WOODS
LANG DR.
WILLOUGHBY DR.
CHELSEA CT.
CABOT CIR.
CRAFTSBURY CT.
FOX RUN CIR.
THISTLE LN.
CEDAR ST.
CEDAR CT.
BLUESTEM RD.
BOBOLINK CIR.
BIXBY CIR.
ALDER LN.
CLOVER DR.
BLACKBERRY RD.
JOSEPH THOMAS LN.
IRENE AVE.
MARION AVE.
LAMELL AVE.
FREDERICK RD.
BROOKS CIR.
CYNTHIA LN.
CYPRESS CT.
OAKWOOD DR.
WOODLAWN CIR.
EBBY HOLLOW CT.
CRIDY CT.
CLENWOOD DR.
TANGLEWOOD DR.
ROSEWOOD TRAIL
LINDEN LN.
CEMETERY RD.
PERRY DR.
LAVIGNE RD.
CHASE DR.
JUNIPER DR.
TOWER WIGHT DR.
WHITCOMB MEADOWS LN.
DEER CROSSING LN.
WHITETAIL LN.
MAPLELA WN DR.
FOUNDERS RD.
CLARA HILL LN.
FOSTER RD.
LASALLE DR.
MARGARET ST.
PATRICIA CT.
POINTE DR.
BUTTERNUT CIR.
SAGE CT.
PARTRIDGE DR.
INDIGO LN.
LAUREL DR.
HOLLOW DR.
SAXON HILL
HILLSIDE CIR.
ALDERBROOK RD.
GREENBRIAR DR.
GREENFIELD CT.
LOGWOOD CIRCLE
RANGER ST.
KIMO DR.
NO. WILLISTON RD.
OLIVE BROOK TERR.
SAXON HILL
GARDENSIDE CIR.
LANDFILL LN.
COLCHESTER RD.
DISCOVERY WOODS
LECLERC LAMORE
GENTES RD.
McGEE RD.
INDIAN BROOK
WALDENWOODS
STAGE RD.
COL. PAGE RD.
DOUGLAS RD.
SMOKEY ASH CHAPIN RD.
BROWNS HILL
OSGOOD RD.
HOLLOW RD.
RIVER RD.
NEW ENGLAND DR.
GAUTHIER DR.
KELLOGG RD.
MORSE DR.
TURCOTTE AVE.
WILSON BYPASS
WILSON ROAD
COLBERT ST.
BLAIR RD.
PIONEER ST.
SUSIE WILSON
PRESCOTT ST.
DAMON DR.
ABARE AVE.
DAVID DR.
MARKET PL.
EWING PL.
SYDNEY PL.
JOSHUA DR.
DANIEL DR.
GLADE PL.
WOODSIDE DR.
PARIZO DR.
KIMBERLY DR.
SLUTHDOWN CT.
DEVON CT.
THISTLE CT.
DARTMOOR CT.
CAMPSHIRE CT.
TURNBERRY RDG.
ST. JOHNS RD.
ST. LAWRENCE RD.
ST. ANDREWS RD.
ST. ORLEANS RD.
ESSEX WAY
LIDIA DR.
MEGAN RD.
REPA DR.
TONEY CT.
BASHAM DR.
DEBRA CT.
WILDWOOD RD.
CREEK RD.
FOREST RD.
SKYLINE DR.
RIDGE RD.
EVERGREEN CT.
STONEBROOK CIR.
WINDRIDGE ROAD
HEATHERBUSH RD.
WINTERPLACE CIR.
WALKER DR.
KURK DR.
RIVER DR.
KINSMAN DR.
RAYMOND DR.
PINEWOOD DR.
VALLEYVIEW DR.
CROSSROAD DR.
DIXIE DR.
BROOK CIR.
KAMLIN LN.
TIMBERLINE DR.
CIRCUMFERENTIAL HIGHWAY

Essex Junction

The Village of Essex Junction currently manages its municipal streets in the following way:

1. The Village has about 112 acres of impervious roadway surface that it manages both for catchbasin cleaning, street sweeping and leaf and litter control. Most of the Village streets are curbed or bermed on the roadway edge. The Village owns a 2013 vacuum sweeper and sweeps the streets 2x/year during the sweeping season. Main travel routes are swept 3-4x/yr. The Village also has a vactor and cleans catchbasins on average about 1 basin/2years. The Village does not have a municipal leaf collection program. Catchbasin cleanings, leaves and street sweeper materials are stockpiled separately at the WWTP at 69 Cascade St. The Village has not adopted an ordinance that prohibits residents from placement of leaves in the street

2. If the Village were to implement a higher frequency of street sweeping during October-November on the blue and green sweeping routes and adopt the Wisconsin DNR method of leaf management it could achieve a 12.9 kg/yr. net phosphorus reduction from Essex Junction Village Streets to the Winooski River and Malletts Bay. This would require an increase from 2-3 sweepings per year on these routes to 6-8 sweepings per year. The sweeping frequency would need to be adjusted to 2x/October and 2x/November. The Village's current sweeping practices have been in effect since about 2008 and therefore the credit has been prorated to the time frame of the TMDL monitoring period (2000-2009). The current sweeping practice removes about .65 kg/yr. of phosphorus from Essex Junction Streets to the Winooski River and Malletts Bay. Similarly, the Village's catchbasin cleaning practice has been in place since 2008. Therefore, the total creditable practices are 1.12 kg/yr.

3. There is a Lake Champlain TMDL phosphorus control plan requirement for the Village of Essex Junction and the current practices achieve about 5% (1.12 kg/yr.) of the target (23.08 kg/yr.). The target includes 2 different SWAT drainages as shown.

4. The attached table lists ineligible routes first (<17 percent tree cover) and then eligible routes by SWAT model drainage area ranked from highest to lowest in percentage of tree cover. The ranking places the highest phosphorus loading routes first based on the fact that there is a linear relationship between leaf area cover and dissolved phosphorus loading (Janke, 2018).

5. The Village of Essex Junction implemented their current catchbasin cleaning practice after 2008, and as stated above, it is therefore a creditable practice. If the Village were to adopt the most effective practice for catchbasin cleaning (2x/yr.) it could achieve a credit of 2.27 kg/yr.

			CATCH BASIN CLEANING				STREET SWEEPING		
MS4	SWAT Drainage Area	TMDL Target Municipal Roads Phosphorus Load Reduction (kg/yr)	Approximate Year Current CB Cleaning Practice Implemented	Current CB Cleaning Credit % of Target Prorated (-10%/yr) to TMDL Monitoring Period (2000-2009)	Current Catchbasin Cleaning Frequency	Max P Load Catchbasin Cleaning Credit (Assumes cleaning 2x/year) (kg/yr)	Approximate Year Current Sweeping Practice Implemented	Current Sweeping Credit % of Target Prorated (-10%/yr) to TMDL Monitoring Period (2000-2009)	Total Credits for Current Practices as % of Target
Essex Junction	Malletts Bay - DD	7.72	2008	1.95	1 every 2 years	0.75	2000/2013	3.42	5.4
Essex Junction	Winooski River	15.36	2008	1.98	1 every 2 years	1.52	2000/2013	2.58	4.6

								LEAF MANAGEMENT	
Sweeper Route ID	SWAT Drainage Area	Sweeping Frequency	Loading Rate kg/ac/yr	Route Acres per SWAT Drainage	Impervious acreage per SWAT Drainage	Tree Cover Percentage Per SWAT Drainage	Phosphorus Load kg/yr	Route Credit if Wisconsin Method Implemented kg/yr	Total Additional Credits as % of Target
Red	Malletts Bay - DD	2x/yr mainly	0.83	60.0	32.3	<17%			
Red	Winooski River	2-3x/yr mainly	1.12	13.8	9.2	<17%			
Green	Winooski River	2x/yr mainly	1.12	23.7	11.9	27.8	13.3	2.3	14.7
Green	Malletts Bay - DD	2x/yr mainly	0.83	21.3	10.6	22.5	8.8	1.5	19.3
Blue	Winooski River	2x/yr mainly	1.12	88.8	48.2	21.2	53.9	9.2	59.6

Malletts Bay - DD	8.78	1.49	19.34
Winooski River	53.87	9.16	59.63

Winooski River

Malletts Bay - DD

VT-15

VT-2A

VT-117

Sweeper Routes > 17% forested

- Malletts Bay - DD (Malletts Bay), Green
- Winooski River (Main Lake), Green
- Winooski River (Main Lake), Blue

Sweeper Routes < 17% forested

- Winooski River (Main Lake), Red
- Malletts Bay - DD (Malletts Bay), Red

Essex Junction Sweeper Routes

N

Credit Requirement	**Barre**	**Montpelier**	**Burlington**	**Essex Junction**	**Essex**	**Shelburne**	**St. Albans**	**South Burlington**	**Winooski**
Routes with curb and gutter drainage systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eligible Routes (Routes with tree canopy 17% or greater)	BC1-Red BC3-Orange BC4-Green BC5-Purple BC6-Black BC7-Yellow	All Routes	BT8 BT9 BT10 BT12 BT13 BT14 BT15 BT17 BT18 BT19 BT21 BT22 BT23	Blue Green	EX22 EX24 EX19-21 EX11 EX14 EX17-18 EX15-16 EX4 EX8-9 EX6-7 EX25-26 EX12	North South	East	SB2 SB3 SB13-16 SB20-24 SB25-26 SB6 SB9	W3 W5
Ordinance prohibiting residents from placement of leaves in the street.	No	Yes	Yes	No	No	No	No	No	No
Municipal leaf collection provided at least 4 times in October and November	No 6-8x/yr.	Yes	Yes, for BT1, BT2, BT5	No 2-3x/yr.	No 2x/yr.	No 2x/yr. with some fall sweeping	No, 8x/yr	No 2x/yr. with some fall sweeping	No, 8x/yr
Within 24 hours of leaf collection, remaining leaf litter in the street must be collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Essex

The Town of Essex currently manages its municipal streets in the following way:

1. The Town has about 134 acres of impervious roadway surface that it manages both for catchbasin cleaning, street sweeping and leaf and litter control. Most but not all of the Town streets are curbed or bermed on the roadway edge. The Town owns or shares a 2013 vacuum sweeper and sweeps the streets 2x/year during the sweeping season. Swept material and catchbasin cleaning material are disposed of at the Essex Transfer Station on Landfill La. The Town also shares a vactor and cleans catchbasins on average about 1 basin/4 years. The Town does not have a municipal leaf collection program. Catchbasin cleanings, leaves and street sweeper materials are stockpiled separately at the Essex Transfer Station. The Town has not adopted an ordinance that prohibits residents from placement of leaves in the street.

2. If the Town were to implement a higher frequency of street sweeping during October-November on the eligible routes and adopt the Wisconsin DNR method of leaf management it could achieve a 21.4 kg/yr. net phosphorus reduction from Essex Streets to the Lamoille River, the Winooski River and Malletts Bay. This would require an increase from 2 sweepings per year on these routes to 6 sweepings per year. The sweeping frequency would need to be adjusted to 2x/October and 2x/November. The Town's current sweeping practices have been in effect since about 2003 and therefore the credit has been prorated to the time frame of the TMDL monitoring period (2000-2009). The current sweeping practice removes about .75 kg/yr. of phosphorus from Essex Streets to the Lamoille River, Winooski River and Malletts Bay. Similarly, the Town's catchbasin cleaning practice has been in place since 2008. Therefore, the total creditable practices are 1.03 kg/yr.

3. There is a Lake Champlain TMDL phosphorus control plan requirement for the Town of Essex and the current practices achieve about 3% (1.03 kg/yr.) of the target (36.98 kg/yr.). The target includes 3 different SWAT drainages as shown.

4. The Tree Cover Percentage Per SWAT Drainage column lists in bold the routes (EX6, , 12, 22) with the highest phosphorus loading zone per SWAT based on the fact that there is a linear relationship between leaf area cover and dissolved phosphorus loading (Janke, 2018).

5. The Town of Essex implemented their current catchbasin cleaning practice in 2008 and as stated above it is therefore a creditable practice. If the Town were to adopt the most effective practice for catchbasin cleaning (2x/yr.) it could achieve a credit of 3.31 kg/yr.

			CATCH BASIN CLEANING				STREET SWEEPING		
MS4	SWAT Drainage Area	TMDL Target Municipal Roads Phosphorus Load Reduction (kg/yr)	Approximate Year Current CB Cleaning Practice Implemented	Current CB Cleaning Credit % of Target Prorated (-10%/yr) to TMDL Monitoring Period (2000-2009)	Current Catchbasin Cleaning Frequency	Max P Load Catchbasin Cleaning Credit (Assumes cleaning 2x/year) (kg/yr)	Approximate Year Current Sweeping Practice Implemented	Current Sweeping Credit % of Target Prorated (-10%/yr) to TMDL Monitoring Period (2000-2009)	Total Credits for Current Practices as % of Target
Essex	**Lamoille River**	**3.82**	**2008**	**0.61**	**1 every 4 years**	**0.23**	**2003**	**2.13**	**2.7**
Essex	**Malletts Bay - DD**	**6.64**	**2008**	**0.66**	**1 every 4 years**	**0.55**	**2003**	**1.72**	**2.4**
Essex	**Winooski River**	**26.52**	**2008**	**0.76**	**1 every 4 years**	**2.54**	**2003**	**2.14**	**2.9**

									LEAF MANAGEMENT	
Town Route	Sweeper Route ID	SWAT Drainage Area	Sweeping Frequency	Loading Rate kg/ac/yr	Route Acres per SWAT Drainage	Impervious acreage per SWAT Drainage	Tree Cover Percentage Per SWAT Drainage	Phosphorus Load kg/yr	Route Credit if Wisconsin Method Implemented kg/yr	Total Additional Credits as % of Target
1	**EX22**	**Lamoille River**	**Two times per year**	**1.14**	**1.8**	**0.9**	**40.1**	**1.0**	**0.2**	**4.4**
1	EX23	Malletts Bay - DD	Two times per year	0.82	12.9	6.4	<17%			
1	EX24	Winooski River	Two times per year	1.12	35.4	19.4	21.6	21.7	3.7	13.9
2	EX19	Lamoille River	Two times per year	1.14	0.1	0.0	53.2	0.0	0.0	0.1
2	EX20	Winooski River	Two times per year	1.12	16.7	8.6	17.5	9.6	1.6	6.1
3	EX21	Winooski River	Two times per year	1.12	24.0	11.7	29.7	13.1	2.2	8.4
4	EX10	Malletts Bay - DD	Two times per year	0.82	15.5	7.1	<17%			
4	EX11	Winooski River	Two times per year	1.12	5.0	2.0	17.2	2.2	0.4	
5	EX13	Malletts Bay - DD	Two times per year	0.82	0.9	0.4	<17%			
5	EX14	Winooski River	Two times per year	1.12	21.9	10.5	18.5	11.7	2.0	7.5
6	EX17	Lamoille River	Two times per year	1.14	2.5	1.0	35.5	1.1	0.2	5.0
6	EX18	Winooski River	Two times per year	1.12	16.7	7.3	26.2	8.1	1.4	5.2
7	EX15	Lamoille River	Two times per year	1.14	20.0	8.8	15.6	10.0	1.7	44.4
7	EX16	Winooski River	Two times per year	1.12	0.0	0.0	21.5	0.0	0.0	
8	EX4	Malletts Bay - DD	Two times per year	0.82	7.2	3.5	<17%			
8	EX5	Winooski River	Two times per year	1.12	6.9	3.6	<17%			
9	EX8	Malletts Bay - DD	Two times per year	0.82	12.1	6.7	20.0	5.6	0.9	14.2
9	EX9	Winooski River	Two times per year	1.12	4.5	2.3	41.9	2.6	0.4	1.7
10	**EX6**	**Malletts Bay - DD**	**Two times per year**	**0.82**	**8.5**	**3.6**	**26.2**	**3.0**	**0.5**	**7.6**
10	EX7	Winooski River	Two times per year	1.12	9.7	4.3	27.0	4.8	0.8	3.1
11	EX25	Winooski River	Two times per year	1.12	29.8	11.3	33.0	12.6	2.1	8.1
12	EX26	Winooski River	Two times per year	1.12	16.4	7.4	22.3	8.3	1.4	5.3
13	**EX12**	**Winooski River**	**Two times per year**	**1.12**	**16.3**	**6.7**	**42.5**	**7.4**	**1.3**	**4.8**

Lamoille River		**12.11**	**2.06**	**53.92**
Malletts Bay - DD		**8.53**	**1.45**	**21.84**
Winooski River		**102.06**	**17.35**	**65.41**

Essex Sweeper Routes

Sweeper Routes > 17% Forest Cover by Swat Drain

	EX11		EX21
	EX12		EX22
	EX14		EX24
	EX15		EX25
	EX16		EX26
	EX17		EX6
	EX18		EX7
	EX19		EX8
	EX20		EX9

VT-15

VT-289

VT-117

Malletts Bay Direct Watershed

Lamoille River Watershed

Winooski River Watershed

N

Essex Sweeper Routes

Malletts Bay Direct Watershed

Winooski River Watershed

VT-2A

VT-15

Sweeper Routes > 17% Forest Cover by Swat Drain

EX11	EX21
EX12	EX22
EX14	EX24
EX15	EX25
EX16	EX26
EX17	EX6
EX18	EX7
EX19	EX8
EX20	EX9

N

Credit Requirement	**Barre**	**Montpelier**	**Burlington**	**Essex Junction**	**Essex**	**Shelburne**	**St. Albans**	**South Burlington**	**Winooski**
Routes with curb and gutter drainage systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eligible Routes (Routes with tree canopy 17% or greater)	BC1-Red BC3-Orange BC4-Green BC5-Purple BC6-Black BC7-Yellow	All Routes	BT8 BT9 BT10 BT12 BT13 BT14 BT15 BT17 BT18 BT19 BT21 BT22 BT23	Blue Green	EX22 EX24 EX19-21 EX11 EX14 EX17-18 EX15-16 EX4 EX8-9 EX6-7 EX25-26 EX12	North South	East	SB2 SB3 SB13-16 SB20-24 SB25-26 SB6 SB9	W3 W5
Ordinance prohibiting residents from placement of leaves in the street.	No	Yes	Yes	No	No	No	No	No	No
Municipal leaf collection provided at least 4 times in October and November	No 6-8x/yr.	Yes	Yes, for BT1, BT2, BT5	No 2-3x/yr.	No 2x/yr.	No 2x/yr. with some fall sweeping	No, 8x/yr	No 2x/yr. with some fall sweeping	No, 8x/yr
Within 24 hours of leaf collection, remaining leaf litter in the street must be collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix E - Essex Stormwater Code Review

Horsley Witten Group
Sustainable Environmental Solutions
112 Water Street • 6th Floor • Boston, MA 02109
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MEMORANDUM

To: Annie Costandi, Town of Essex Stormwater Coordinator

Chelsea Mandigo, Village of Essex Junction Stormwater Coordinator

From: Lori Kennedy and Anne Kitchell, HW

Date: March 29, 2021

Re: Essex Stormwater Code Review

Cc: Amy Macrellis, Stone Environmental; Amanda Ludlow, Stantec

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As part of the Phosphorus Control Plan (PCP) development for the Village of Essex Junction (Village) and Town of Essex (Town), the Horsley Witten Group Inc. (HW) reviewed the following Village and Town documents as they relate to stormwater management:

- Town and Village Stormwater Management Ordinance (Essex Town Ordinance 10.20 and Village Code Section 1901)
- Village of Essex Junction Land Development Code (LDC)
- Village Public Works Details
- Town of Essex Public Works Standard Specifications for Construction
- Town of Essex Subdivision Regulations
- Town of Essex Zoning Regulations

Building on a previous code review completed in 2019 by the Vermont League of Cities and Towns (VLCT), HW targeted this review to evaluate:

- Compliance with Vermont MS4 General Permit requirements,
- Consistency with State stormwater management standards,
- Effectiveness in promoting green infrastructure and environmentally sensitive site design, and
- Opportunities to earn phosphorus-reduction credit.

This memorandum summarizes HW's findings and recommendations, and incorporates feedback provided by Village and Town stormwater staff on the draft memorandum.

MS4 Permit Compliance

HW reviewed the Stormwater Ordinance to assess its compliance with the Vermont MS4 General Permit. Overall, the Stormwater Ordinance and the Village LDC meet MS4 General Permit requirements by:

1) Prohibiting illicit discharges,
2) Requiring construction-site stormwater management on projects disturbing less than 1 acre, and
3) Requiring post-construction stormwater management for projects disturbing more than 1 acre but creating or redeveloping less than 1 acre of impervious cover.

Table 1 summarizes how the Stormwater Ordinance and the Village LDC meet the requirements of the MS4 General Permit and provides recommendations for improving clarity and consistency.

Post-Construction Stormwater Management Consistency with VT General Permits and Guidelines

The MS4 General Permit requires that permittees review their existing policies, regulations, and ordinances to determine their consistency with the requirements of the Secretary's general permits, rules, and guidelines. As a first step toward meeting that requirement, HW completed a preliminary review of the Essex Stormwater Management Ordinance, the Town of Essex Public Works Standard Specifications for Construction, the Village LDC, and the Village Public Works Details to assess their consistency with the substantive requirements of the:

- Vermont General Permit 3-9050 (2020) for Operational Stormwater Discharges,
- Vermont Stormwater Management Manual Rule and Design Guidance (2017), and
- Road Stormwater Management Standards (Municipal Roads General Permit 3-9030, Part 6 and MS4 General Permit, Part 8.3.C.).

This review was not meant to be comprehensive; rather, the focus was on illuminating opportunities to improve local post-construction stormwater management and enable the Village and Town to earn phosphorus-reduction credit toward their reduction target for the Lake Champlain TMDL (per MS4 General Permit Part 8.2). Table 2 summarizes the findings of this review.

Table 1. Village and Town Code Compliance with Vermont MS4 General Permit

MS4 Permit Section	Requirement	Stormwater Management Ordinance (Essex Town Ordinance 10.20 and Village Code Section 1901)		Village Land Development Code	
		Relevant Section/ Provision	Comments/ Recommendations	Relevant Section/ Provision	Comments/ Recommendations
6.2.3.a.(2) Illicit Discharge Detection and Elimination	Applicability: >1 acre land disturbance Requirements: Effectively prohibit non-stormwater discharges into the regulated small MS4 and implement appropriate enforcement procedures and actions.	§10.20.050 Illicit Discharge	Meets MS4 Permit requirements	§713.C Illicit Discharge Detection and Elimination	Meets MS4 Permit requirements
6.2.4.a.(3) Construction-Site Stormwater Management	Applicability: <1 acre land disturbance (state covers >1 acre) Requirements: At a minimum, require implementation of the measures in the *Low Risk Site Handbook for Erosion Prevention and Sediment Control*	§10.20.060 Erosion and Sediment Control Requires erosion and sediment control for all projects and an Erosion Control Permit for projects disturbing <1 acre and creating or redeveloping 0.5 to 1 acre of impervious area. Requires compliance with small-site erosion-control guidelines provided in Appendix A.	Add reference to the *Low Risk Site Handbook for Erosion Prevention and Sediment Control* Either compare and reconcile Appendix A to the Handbook or remove Appendix A	§514: Approval of Activities Involving the Disturbance of Less than One (1) Acre Requires applicant to submit an erosion and sediment control plan indicating compliance with the *Low Risk Site Handbook*. §713.D. Construction Site Stormwater Runoff Control Defines standards for inspection and maintenance of erosion and sediment controls	Meets MS4 Permit requirements

MS4 Permit Section	Requirement	Stormwater Management Ordinance (Essex Town Ordinance 10.20 and Village Code Section 1901)		Village Land Development Code	
		Relevant Section/ Provision	**Comments/ Recommendations**	**Relevant Section/ Provision**	**Comments/ Recommendations**
6.2.5.f.-g. Post-Construction Stormwater Management	Applicability: >1 acre land disturbance and <1 acre of impervious cover created or redeveloped. Requirements: Develop and implement an ordinance that: (1) prevents or minimizes water quality impacts from runoff, (2) utilizes a combination of structural, non-structural, and LID/GSI practices; (3) ensures long-term O&M, and (4) includes procedures for inspecting projects for compliance.	§12.20.070 Development Storm Water Management Applicable to projects that disturb >1 acre and "*create new or is an expansion of old impervious surfaces that are equal to or greater than one-half (1/2) acre*". Exempts additions/modifications to existing single-family homes. Requires stormwater management per VT standards; construction inspections; maintenance easements and as-built plans. §10.20.080 Stormwater Control, Operation and Maintenance Requires maintenance per VT standards; maintenance agreement and covenant, right of entry, and record-keeping.	Meets MS4 Permit requirements Clarify Ordinance applicability language at §12.20.072 Clarify or remove single-family home exemption (should not be exempt if disturbs over 1 acre)	§713.D.4: Stormwater Management Standards Requires site design to minimize runoff; stormwater management per VSMM §713.F Operation and Maintenance of Stormwater Systems Requires O&M plan with inspection and maintenance schedule and responsible party §713.D Procedures for Enforcement of Maintenance Requirements Establishes procedures for enforcing maintenance requirements	Meets MS4 Permit requirements Consider adding a requirement to §713 for submission of as-built plans

Table 2. Consistency with State General Permits and Stormwater Manual

State Permit/Manual	State Requirements	Applicable Local Ordinance/Regulation	Comments/Recommendations
Vermont General Permit for Operational Stormwater Discharges 3-9050 (2020)	Eligible projects include: • Development or redevelopment of one or more acres of impervious surface (changing to ½ acre effective July 1, 2022) • Expansion of existing impervious surface by more than 5,000 square feet, such that the total resulting impervious surface is equal to or greater than 1 acre	Ordinance §10.20.072 • Sets threshold at ½ acre impervious area • Allows acceptance of a VT Stormwater Permit as evidence of compliance Village LDC §515 • Sets thresholds of 1 acre land disturbance or creating a total resulting impervious surface of 1 acre or more • Requires review in accordance with VT GP 3-9020 and GP 3-9015 or other appliable state permits • Requires evidence of compliance with VT state requirements	Ordinance: • Clarify applicability language at §10.20.072 • Review and update definitions (e.g., "land disturbance" and "redevelopment") Village LDC: • Update GP 3-9015 reference to GP 3-9050
Vermont Stormwater Management Manual Rule and Design Guidance (2017)	• Provides instructions for site planning and stormwater treatment practice (STP) • Establishes requirements to meet standards for groundwater recharge, water quality, channel protection, overbank flood protection, extreme flood control, and post-construction soil depth and quality • Defines acceptable STPs and feasibility considerations	Ordinance §10.20.073 and LDC §713.D.4 References the Vermont Storm Water Management Manual (volumes I and II), latest version Ordinance §10.20.074 and LDC §713.D.4 Sets requirements for peak rate control, groundwater recharge, water quality treatment (min. 80% TSS, 40% TP), channel protection, discharge to sensitive resources, hotspots.	Update references to VSMM Reconcile Ordinance Appendix D with VSMM Revise Ordinance §10.20.074 and Village LDC §713.D.4.: • Add/strengthen requirements for low impact development site planning and design • Update %TSS and %TP reduction and TMDL language • Add requirements for flood control and soil quality

State Permit/Manual	State Requirements	Applicable Local Ordinance/Regulation	Comments/Recommendations
Road Stormwater Management Standards (Municipal Roads General Permit 3-9030, Part 6 and MS4 General Permit, Part 8.3.C.	Establishes standards for: • Revegetation of disturbed areas, • Roadway cross-slope, • Shoulder berms • Drainage ditches • Culverts • Catch-basin outlet stabilization	<u>Town DPW Standard Specifications for Construction</u> • Chapter 5 provides technical specifications for streets and stormwater control facilities. • Of particular interest for revisions: o §502.1 Geometric standards for streets Table 1 o §511.2 Open Drainage o §511.5.4 Drainage Outlets o Appendix A – Details <u>Village Public Works Details</u> • Provides typical plan and detail for paved street with catch basins, underdrain	Update Town DPW specifications to match MRGP standards for: • Minimum cross slopes • Drainage swale depth and turn-out • Drainage ditch headwalls • Stone aprons or plunge pools at culvert outlets • Check dam specifications Village Public Works Details: • Consider adding details for unpaved roads, open drainage, drainage outlets, and culverts meeting MRGP standards

Green Infrastructure and Environmentally Sensitive Site Design

HW reviewed the Town's Zoning Regulations, Subdivision Regulations, Stormwater Ordinance, and DPW construction specs and details and the Village LDC to identify gaps and potential barriers to implementing green infrastructure and more environmentally sensitive development projects. The intent of this review was to highlight regulatory areas the jurisdictions may want to revisit when updating the codes. Findings and recommendations are presented below in three general categories: site design, green infrastructure, and climate resilience.

Site Design

Development regulations have a direct impact on how development activities can improve or degrade the local environment. HW noted several areas for each jurisdiction to look at in more detail include:

1. The Town Subdivision/Zoning Regulations and Village LDC do not go far enough with provisions to improve existing stormwater management conditions during redevelopment or road improvements (widening or realignment). As most future development is likely to be redevelopment/infill, these projects present an opportunity to improve existing conditions in impaired watersheds. During the next round of code updates, consider clearly establishing water quality improvement objectives for redevelopment, set thresholds for triggering stormwater retrofits during road or parking lot improvements, or offer incentives for going above and beyond on water quality treatment or open space protection.

2. The Town lighting standards offer an opportunity to better address Dark Sky objectives. This is worth a more detailed dive into what the existing standards are, if they are compliant with Dark Sky, and how willing the Town is to tackle this issue. The Village lighting standards offer a great model to start from. LDC Section 704 has Dark Sky Complaint requirements for residential exterior lighting and is very detailed on commercial and business lighting. Consider extending to other uses such as recreational facilities.

3. The Village LDC includes a 15-foot minimum undisturbed riparian buffer (below the threshold considered protective) but does include some good language related to restoration. We recommend looking at the Town's requirements, which include some good provisions related to stream crossings at right angles, minimum culvert diameters, etc. Also, consider provisions for allowing third parties such as land trusts to manage buffers.

4. Lot geometry, streets, and parking standards can inadvertently restrict creative design, create excess impervious cover, and fail to protect the natural services of urban trees and open space. Based on the Center for Watershed Protection (CWP) Codes and Ordinance Worksheet (for post-construction stormwater), both the Town and Village score relatively high for environmental/water resources protection. Riparian buffer, open space, cluster/village/planned unit developments (PUD) design, and parking provisions are areas where both jurisdictions have done a good job. The Village LDC Section 273 PUD, for example, describes water resource protection goals. Table 3 summarizes several areas related to streets and lot geometry where the regulations differ from CWP recommendations.

Table 3. Current Standards Compared to Center for Watershed Protection (CWP) Standards

Category	CWP Standards	Town of Essex Current Standards	Village of Essex Junction Current Standards
Road width for low volume roads	• 18-22 ft width • 45 ft or less for ROW	• minimum of 24 ft • ROW width of 60ft	• Local residential = 28 ft paved width with 50 ft ROW • Private streets = 20 ft paved and 40 ft ROW widths • Transit-oriented development (TOD) street requirements
Cul-de-sacs	• 70-90 ft minimum diameter • Allow alternative turnaround designs	100 ft; alternative cul-de-sac designs allowed if recommended by Town Engineer (e.g., with island, hammerhead, loop de lanes), but there are no designs in the DPW materials	75 ft diameter, 100 ft ROW
Parking ratios	• 3 spaces per 1,000 gross SF for professional offices (other use ratios also provided). Ratios should be based on actual needs • Shared parking and mass transit provisions • Set maximums	• 4 spaces per 1,000 gross SF • In line with shopping center and SFR ratios • Town did a great job with o flexibility for modifying parking ratio o shared parking provisions o bike space requirements • No required % for compact or electric vehicles	• 3.5 spaces per 1,000 gross SF for professional offices; in line with SFR (2 per dwelling) • Ratio based on "net uses" for shopping centers • TOD parking ratios all meet • Waiver criteria allow for reductions based on shared parking, usage studies, and other
Minimum frontage and setback requirements for an equivalent ½ acre residential	Frontage: <80 ft Front Setback: ≤20 ft Rear: ≤25 ft Side: ≤8 ft	• Low residential lot meets min rear yard, but exceeds front (25-40 ft), side (10-15 ft) and frontage (100 ft) • PUD can meet rear (15-20 ft) and frontage (75-100 ft) • This may not be critical if Town is not having problems with creative designs	• R-1 and R-2 both meet all recommended setbacks and frontage • TOD has no min setbacks and sets a max front setback of 20 ft
Sidewalks	• 4 ft min • Encouraged alternative layouts • Pitch to pervious	• 5 ft minimum • Required on two-sides (except for dead end streets) • Should allow for more flexibility to use alternative pedestrian paths that do not follow road layout	• 8 ft min in TOD, but within context of pedestrian friendly design
Driveways	• 9 ft minimum width • Shared driveways	• 10 ft min width • Shared driveway provisions provided but there is a limitation to 2 dwellings	• 12 ft minimum, 20 ft max • Up to 5 dwellings shared driveway

Green Stormwater Infrastructure

HW identified several areas that could present barriers to widespread implementation of green stormwater infrastructure within the Town and Village regulations and DPW materials. Table 4 summarizes these areas for a more detailed look:

Table 4. Opportunities to Advance Green Infrastructure in Codes

Category	Town of Essex	Village of Essex Junction
Definitions	• Ensure that there is consistency between definitions in regulations and stormwater ordinance • Revisit definitions of hard surface, impervious cover, stormwater retention, runoff, and streetscape to make sure they are not prohibitive to green infrastructure • Consider addition of terms "watershed", "retrofit", "buffer restoration", "unpaved road" or other MS4 Permit-related terms	
Documentation	• Application materials (i.e., site plan review applications) should include information on watershed, TMDL targets, and pollutant load calculations • Make a break from mylar? Consider requirements for hard copy plan sets and feasibility of including/or switching over to digital design plans, as-builts, etc. Would geospatial or spreadsheet-based submittal of drainage infrastructure data assist in development of tracking database for inspection and maintenance? Be consistent with Public Works specifications.	
BMP preferences and specifications	• Multiple locations in the regulations and DPW specifications list specific BMP types (temporary or post-construction) as preferred practices. These do not include newer generation stormwater technologies or an emphasis on the volume reduction benefits of green infrastructure (recharge, reuse, evapotranspiration). • Silt fence and pond references, for example, should be replaced (or at least expanded upon) to include filter socks, bioretention, rainwater harvesting, etc. • The erosion and sediment control requirements in DPW materials could use an update, especially as relates to inspection procedures, preferred practices, and use of fertilizer for seeding (without soil test). • There are several references to plastic mesh erosion control matting that should be removed.	• Similar to Town comments. • We recommend the Town and Village update and combine DPW specifications and standards. Review for consistency with Stormwater Ordinance Appendix D and consider consolidating Appendix D with DPW standards.

Category	Town of Essex	Village of Essex Junction
Permeable pavement (or any alternative to concrete or asphalt)	• Not currently mentioned • Allow flexibility for use of pervious materials in parking lots, driveways, streets, sidewalks, etc. • If the Town wants to promote permeable pavements or exert control on the material specifications and construction requirements, will need to update specs.	• LCD Section 909 walkways and bike paths. Does concrete, bituminous paving, or gravel requirement prohibit permeable pavement alternatives?
Curbing	• Mentioned frequently as being required (although "partial curbing" appears once) • Could be interpreted as a barrier to alternative road designs or green streets depending on how the Town Engineer is applying the regulations.	• Section 906 requires all streets to have curbing on each side but does offer a waiver option. Would be better if allowed alternatives for stormwater management.
Street trees	• No explicit prohibition of tree pits or other vegetated BMPs, but there is no mention of the benefits of trees for stormwater management or other co-benefits that would make it a more accepted practice. • Parking lot requirement for trees that requires raised curb and landscaping could be prohibitive for use of bioretention and other vegetative surface practices. • The Town already has areas in the code dedicated to trees and landscaping and it may be worth establishing urban and rural tree management goals in the context of stormwater, climate, and human health objectives.	• Landscaping requirements in Chapter 2 General Regulations for Public Streets may want to explicitly address vegetation management for stormwater practices placed in the road ROW. • 710. Is there an issue with GI in the visibility triangle. If not, will want to specify low veg <30 inches. • 719. Landscaping. Great job outlining role of trees and landscaping in heat reduction, energy efficiency, stormwater management, air quality; Mature tree credit, salt tolerant, parking lot landscaping for stormwater are mentioned, performance bond etc. • Town should look at Village requirements when they merge
O&M	Evaluate costs to the Village/Town for long-term O&M of accepted roads and associated drainage/stormwater facilities and operational permits. Consider revisions to fee schedules to ensure sufficient funding for ongoing street sweeping, catch basin cleaning, and stormwater facility maintenance and replacement.	

Climate Resilience

HW also identified areas with the Town and Village regulations that present opportunities to promote climate mitigation and adaptation:

1) Do more to promote rainwater harvesting and reuse as a viable option for runoff reduction and water conservation.
2) Consider requiring a percentage of parking spaces at businesses and public properties to be dedicated for hybrid or electric vehicles to encourage reduced phosphorus loads from combustion engines. Consider offering incentives for installing electric vehicle charging stations.
3) For solar arrays, consider establishing specific zoning standards that outline siting preferences; tree, forest, viewshed protection objectives; and allowable/unallowable hydrologic alterations. Also consider adding design standards for parking lot solar awnings/covers.
4) For tree canopy cover in parking lots, consider adding language that references cooling, air quality, rainfall interception, and evapotranspiration benefits as objectives and establishing percent coverage targets.
5) Open space & Floodplain district regulations could include more emphasis on maintaining or restoring watershed function and improving the Town's resiliency rather than just ensuring recreational access. Similarly, the Village's LCD Section 6 Flood Plain could do a better job of linking floodplain function with climate resilience. Consider adding language related to invasives management, reforestation, and buffer enhancement to open space, buffer, or mitigation sections.
6) Add carbon calculation requirements as part of application packages as a way to help decision-makers evaluate the cost/benefit of site development proposals.
7) Add to landscaping language about using tree species that are more adaptive to changing climate patterns.
8) Add language requiring new public buildings to meet LEED standards, at a minimum, or achieve certification, at best.

Phosphorus-Reduction Crediting Opportunities

The MS4 General Permit allows permittees to take phosphorus-reduction credit for "implementation of municipal ordinances or other regulations to address sub-jurisdictional impervious surfaces." The following sections describe Stormwater Ordinance and Village LDC changes that the Village and Town might consider to enable phosphorus-reduction credit on non-municipal projects that are not otherwise subject to an operational stormwater permit.

Applicability Thresholds (Subjurisdictional Projects)

With the Ordinance's current applicability threshold for *Development Storm Water Management* (§10.20.072), the Village/Town can take phosphorus-reduction credit for stormwater treatment practices (STPs) on projects creating or redeveloping between 0.5 acre and 1 acre of new impervious cover. When the state lowers its applicability threshold for operation permits in July 2022, that credit will end unless the

Village/Town lowers the Ordinance applicability threshold. HW recommends that the Village and Town consider requiring smaller projects (e.g., creating or redeveloping >10,000 sf of impervious cover) to apply for a local stormwater permit.

Before selecting a lower threshold, HW recommends that the Town and Village evaluate the potential costs and benefits of different threshold levels. Considerations might include:

- How many projects would be expected at each threshold level (e.g., >10,000 sf, >5,000 sf),
- Typical phosphorus reduction credit for those projects,
- Staff hours required for permit application review, inspections, enforcement, and tracking.

Phosphorus-Reduction Documentation

The Town currently requires Stormwater Permit applicants, including those permitted under a state Operational Permit, to submit all stormwater plan documents and phosphorus reduction calculations. The Village does not currently require submission of stormwater plan documents and calculations for projects receiving state permits. HW recommends revisions to the Stormwater Ordinance §10.20.072 (State Permits paragraph), §10.20.076, and Appendix C, and the Village LDC §513, §514, and §713.D.4 to require stormwater management plan submissions (for local and state permits) to include all data needed to document phosphorus loading and reductions (pre- and post-development site land use and impervious cover; subwatershed; impervious and pervious drainage area; STP type, volume, and infiltration rate; phosphorus load, removal efficiency, and reduction). To improve tracking efficiency, HW recommends requiring standardized data submission via an online form (linked to ArcGIS online database) or using VT DEC's BMP Tracking Table spreadsheet.

Long-term Operation and Maintenance (O&M)

For MS4 permittees to take credit for phosphorus reduction on subjurisdictional projects, the MS4 General Permit requires that: "*the MS4 shall establish a maintenance agreement with the property owner(s) to ensure long-term maintenance of the BMP(s). The maintenance agreement can be conditions in a local permit, or part of a municipally-approved plan*." DEC issued informal guidance in 2019 that MS4 permittees would need to ensure maintenance of structural practices for subjurisdictional projects, beyond requiring long-term O&M as part of a local permit.

The Ordinance and Village LDC currently include requirements for routine maintenance, inspections, maintenance agreement and covenant, right-of-access for inspections, and record-keeping. HW recommends clarifying with DEC whether the Village/Town will need to report annually on inspections/maintenance of subjurisdictional STPs, and if so, what form that may take. The Village/Town could consider requiring an annual self-report from holders of local stormwater permits, certifying that they have inspected and maintained their STPs in accordance with their O&M plan. Self-reporting would be paired with an audit by Village/Town staff of a select number of permits and STPs annually. Alternatively, the Village/Town staff could annually inspect those STPs themselves.

Offsite Stormwater Mitigation

If the Village/Town decide to reduce the Ordinance applicability threshold below 0.5 acres, HW recommends exploring options to formalize a program for offsite stormwater mitigation. The Village LDC does not include provisions allowing for offsite mitigation. The Ordinance includes language at §10.20.100 allowing the Town to waive stormwater management requirements for projects that meet certain conditions, as long as acceptable mitigation measures are provided. Among the acceptable mitigation measures are: 1) the creation of a stormwater management facility or other drainage improvements on previously developed properties that lack adequate stormwater facilities, and 2) monetary contributions (fee-in-lieu) to fund stormwater management activities "such as research and studies". The section also states that if a project is granted a waiver, the applicant must "pay a fee based on the impact of the impervious area created in an amount to be determined by the Town."

The Village and Town could consider several regulatory revisions that would provide flexibility for optimizing stormwater management locations, maximizing phosphorus reduction, and easing phosphorus-reduction tracking and crediting. Options may include:

1) Eliminating the waiver allowance at Ordinance §10.20.100.
2) Requiring on-site stormwater management to the maximum extent practicable, as demonstrated with an engineering feasibility analysis.
3) Or, establishing other criteria by which applicants would demonstrate eligibility for offsite mitigation.
4) Allowing applicants to pay a stormwater impact fee in lieu of fully meeting stormwater standards on site. The Village and Town could allocate those funds toward retrofit projects identified in the Village/Town Phosphorus Control Plan.
5) Allowing applicants to directly implement STPs at an approved offsite location to provide equivalent stormwater mitigation.